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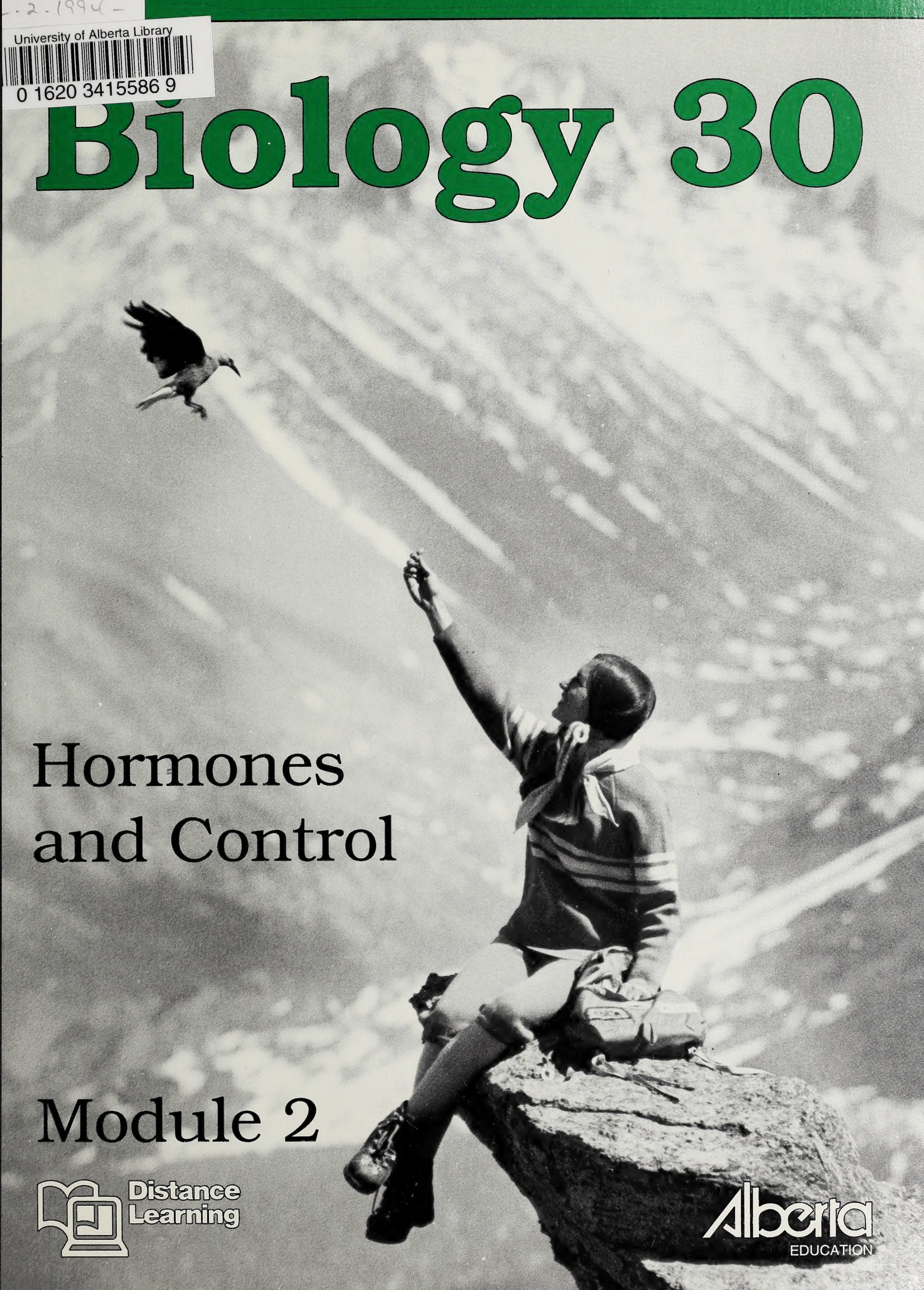

Hormones and Control

Module 2

Distance Learning

Alberta
EDUCATION

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Biology 30

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Hormones and Control

Distance Learning

Alberta
EDUCATION

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Teachers (Biology 30)	✓
Administrators	
Parents	
General Public	
Other	

Biology 30
Student Module
Module 2
Hormones and Control
Alberta Distance Learning Centre
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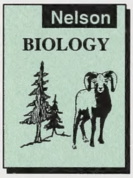
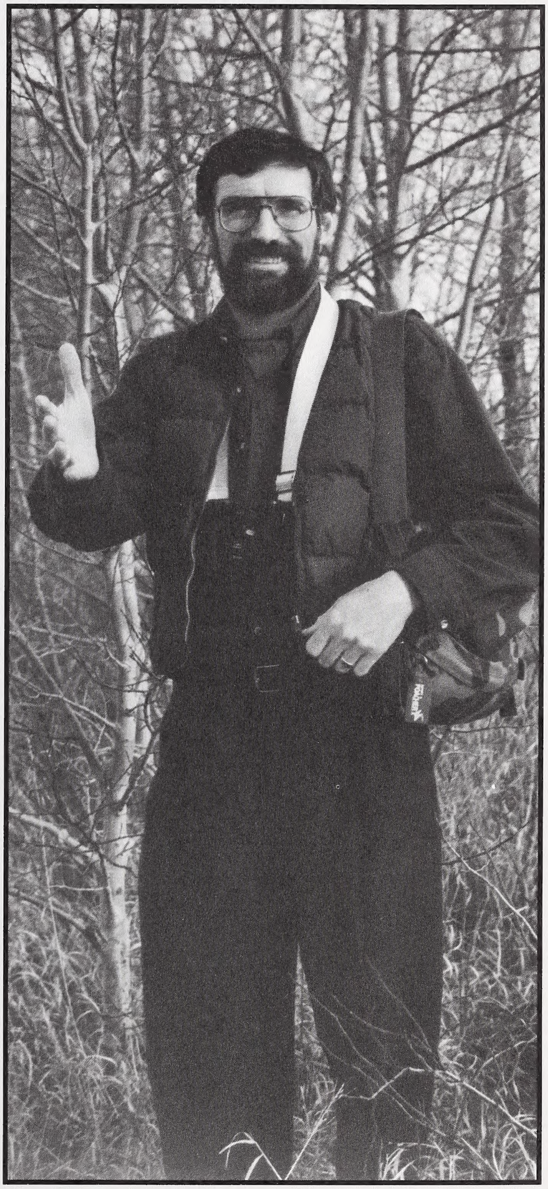
Welcome to Module 2

We hope you'll enjoy your study of *Hormones and Control*. Remember, to make your learning a bit easier, several videocassettes and laser videodiscs are referred to throughout the modules. Your textbook, *Nelson Biology*, will enhance your studies.

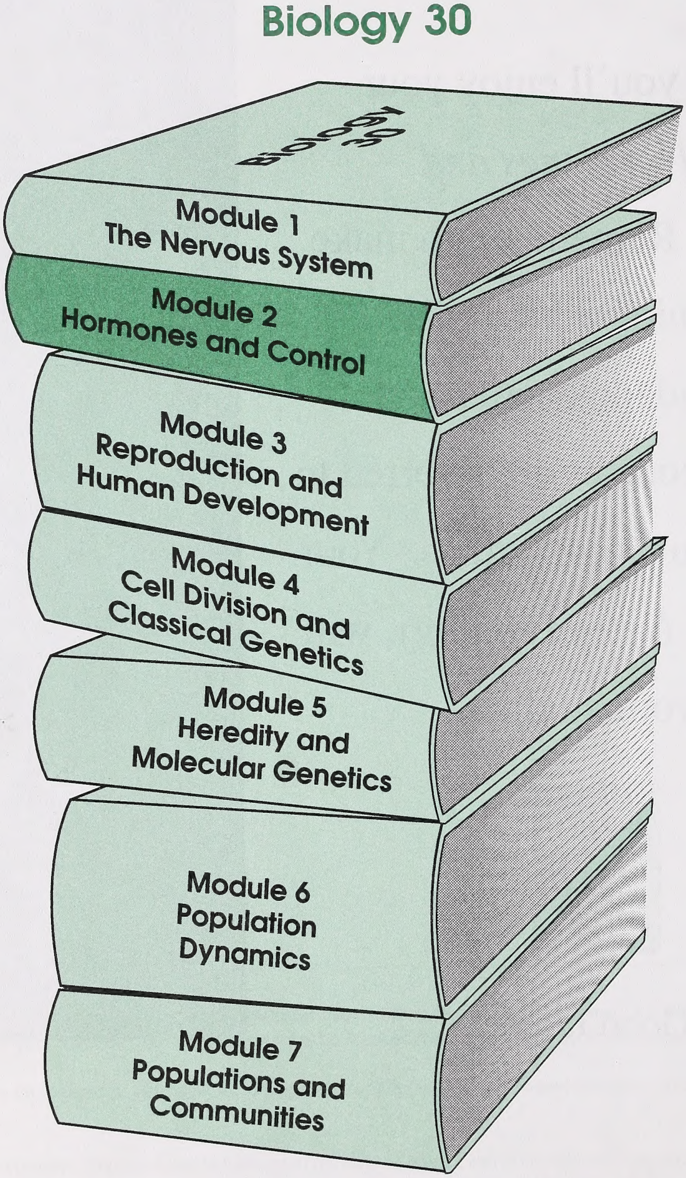


Good Luck!



COURSE OVERVIEW

This course contains seven modules. The module you are working in is highlighted in a darker colour.



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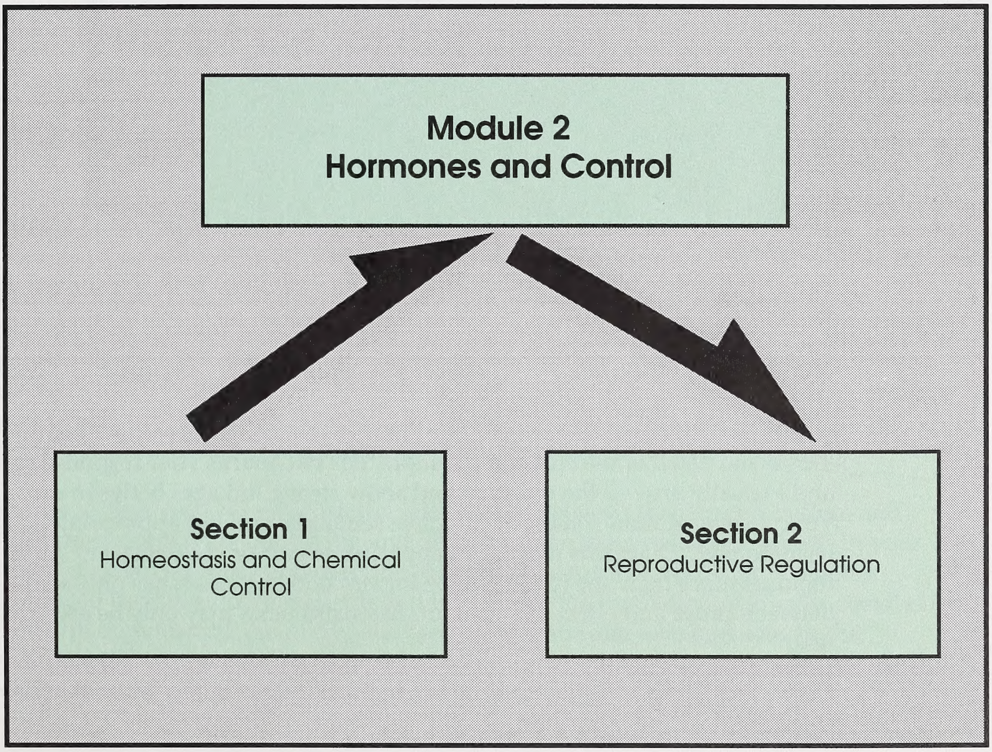
MODULE OVERVIEW

Have you ever been nervous about something such as attending your first day of high school or going for your driver's test? What about asking someone for the first time to go out on a date? Do you remember what you felt like in that situation? Were you hot and sweaty, numb, or not able to think straight?

What about growing up? Did you experience a big growth spurt in your teens? If you're a female, when did you first experience changes in your body that informed you that you were becoming a woman? If you're a male, when did you first begin shaving?

These experiences are partially due to your nervous system which you studied in the last module, but are also due to chemicals in your body called hormones. These hormones are the focus of this module.

In this module you will study and investigate how hormones in your body maintain **homeostasis**. You will become familiar with the major hormones in your body along with their particular functions. By gaining understanding of the role hormones play in reproduction and the development of secondary sex characteristics, you will develop an appreciation for the significance of hormones in biotechnology.



Evaluation

Your mark in this module will be determined by how well you complete the assignments at the end of each section. You must complete all assignments. In this module you are expected to complete two assignments. The mark distribution is as follows:

Section 1 Assignment	**60 marks**
Section 2 Assignment	**40 marks**
TOTAL	**100 marks**

When doing your assignments, work slowly and carefully. If you are having difficulties, go back and review the appropriate section.

Read all parts of your assignment carefully. Plan and do your rough work on your own paper. Revise and edit your responses; then set up your final copy for submission on your own paper. Lined looseleaf is recommended. Make sure your answers are neat and organized, with wide left margins and space for teacher comments after each assignment.

Response Page Setup

When you see this icon, ideas and details are provided to help you set up and organize your answer in a certain way.

Before submitting your responses, be sure to proofread them carefully to ensure they say what you want, that they are neat and clear, and that they are complete and missing no material.

You will be submitting **only** your **assignment response pages** for evaluation.

It is important to number and clearly identify each page with this information placed at the top.

Biology 30 – Module 2   Section # Assignment   Page #   Name and ID #

Notice that for some assignment questions two marks are given for communication. This is indicated at the end of a question. For two marks your response should clearly and logically answer the question and show strong linkages between cause and effect. Your answer should consist of complete sentences and use appropriate scientific terminology. Diagrams may be an appropriate part of your answer. An answer that requires more than one reading to be understood because it has only weak linkages between cause and effect and contains inconsistencies may only be awarded one mark or less.

SECTION 1 Homeostasis and Chemical Control

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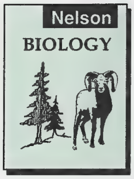
Have you ever heard of superfeats of strength performed in an emergency? In emergencies humans have been known to rip open locked doors and even lift part of a vehicle clear off the ground to free a trapped individual. Where could extraordinary strength like this come from? Hormones play a major role in allowing you to perform acts which you would not be able to do under normal circumstances. Besides this, hormones are important in maintaining balance or homeostasis in your body.

In this section you will establish the relationship between the nervous system and hormones along with identifying and describing the main endocrine glands in your body. You will identify and describe the metabolic roles of the major hormones produced by the endocrine glands and investigate the regulation of glucose metabolism. You will demonstrate the role of aldosterone and antidiurectic hormone in the maintenance of homeostasis of water and ions in your body. You will also develop an understanding of the use of hormones in biotechnology.

ACTIVITY 1

Endocrine Glands and the Nervous-Hormonal Connection

Hormones are chemicals secreted by the endocrine system. What is the relationship between the nervous system and hormones? Is there a common function associated with these systems? Both systems are involved with communication and coordination which allows for homeostasis to be maintained in the body.



To begin establishing the relationship between the nervous and hormonal systems, read the sections entitled Importance of the Endocrine System and Chemical Control Systems on pages 332 to 334 and answer the following questions.

1. Define the terms *hormone* and *target tissue.*

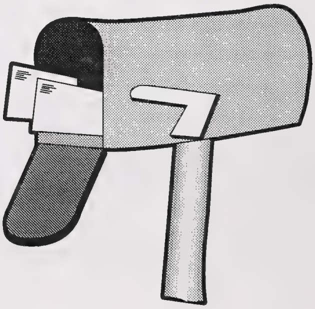
2. By designing a chart, contrast the mode of transmission, duration of effect, and reaction time of the nervous system and the endocrine system.

Check your answers by turning to the Appendix, Section 1: Activity 1.

Another contrasting characteristic between the two systems is that the nervous system is more specific in terms of its target area. The endocrine system response is usually broader than that in the nervous system. With reference to the photograph at the beginning of the section, the major hormone acting on an individual in an emergency is adrenaline, which has an effect over the entire body. In comparison, when you touch a hot object with your hands, your nervous system responds by having you pull your hand away (withdrawal reflex); but your entire body does not respond, just your arm and maybe your voice.

To help you remember, think of it this way:

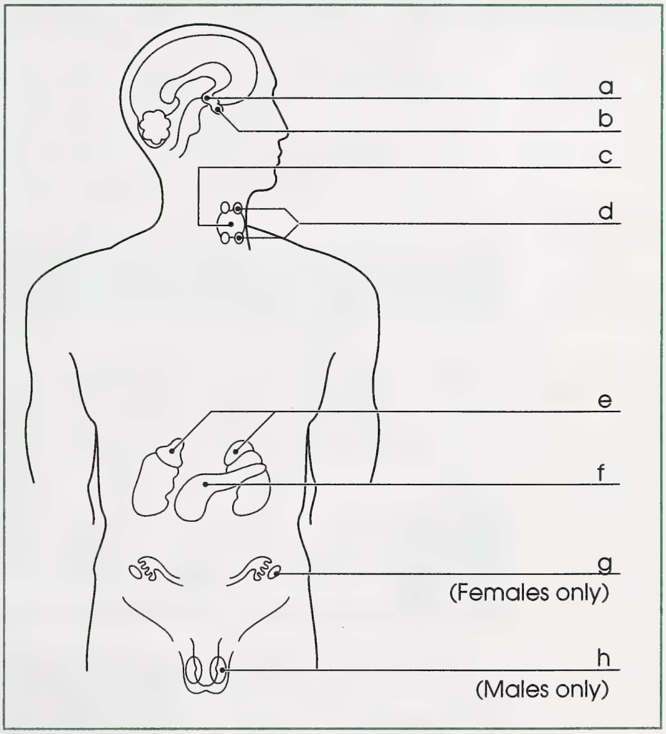
In terms of time of response, you can think of the nervous system as the telephone system and the endocrine system as the mail system. Notice which one is faster, which one uses an electronic signal, and which one delivers an actual package instead of just information.



There are other relationships which exist between the endocrine system and the nervous system. The endocrine and nervous systems are closely related structurally, chemically, and functionally. Some endocrine glands contain nervous tissue. Chemically, some substances, such as adrenaline, act as both hormones and neurotransmitters. Functionally, both systems work together in controlling physiological processes. Keep these relationships in mind as you go through the rest of the module. Refer to pages 336 to 345 and look for the location of each gland.

3. Identify these glands in the diagram on the right. For the present, just identify the glands. Do not record their functions.

As you can see, the endocrine glands are located in various places in the body.



4. Identify the pair of structures located below the adrenal glands.

Now that you have a better idea of where the endocrine glands are in your body, you're ready to take a closer look at the neuroendocrine connection. This is the link between the nervous system that conveys sensory information and the endocrine system that responds with a controlling chemical.

Read the section entitled The Pituitary: The Master Gland on pages 336 to 337. At this point, do not worry about the specific hormones, but concentrate on the relationship between the nervous system and the endocrine system.

5. Design a flowchart illustrating the neuroendocrine connection between the nervous system and the endocrine system.

You can see that there is a very important relationship between the hypothalamus and the pituitary gland. Keep in mind that the pituitary gland is the "master gland" but it is the hypothalamus that controls the actions of the pituitary. The hypothalamus determines the actions of the pituitary by receiving information from sensory neurons scattered throughout the body and by monitoring the chemical balance in the bloodstream.

6. Using the information from question 5 and the previous paragraph, design a general pathway illustrating the series of events which would occur in your body if you were confronted by the dog illustrated in the diagram. Hint: Begin with the use of your senses.

Check your answers by turning to the Appendix, Section 1: Activity 1.

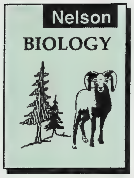
In this activity you have examined the relationship between the nervous system and the endocrine system. You have also identified the major endocrine glands of the body. In the next activity you will study the major hormones released from the endocrine glands.

ACTIVITY

2 Endocrine Action

Picture this. You have just finished your homework and are starting to relax when the phone rings. Your best friend has two free tickets to a sold-out hockey game. Can you be there in fifteen minutes? Your mind and your body shift into high gear. What exactly happens and why?

In this activity you will examine specific functions of major hormones that control short and long-term changes in your body that help you adjust to your constantly changing environment.



1. Using information from pages 332 to 340 and pages 344 to 345 of the text, complete the following table.

Endocrine Gland	**Hormone**	**Target Cells**	**Primary Function**
posterior pituitary	antidiuretic hormone (ADH) (vasopressin)		
anterior pituitary	growth hormone (GH)		
	thyroid-stimulating hormone (TSH)		
	adrenocorticotropin hormone (ACTH)		
parathyroid	parathyroid hormone (PTH)		
pancreas	insulin		
	glucagon		
adrenal medulla	adrenaline (or epinephrine)		
	noradrenaline (or norepinephrine)		
adrenal cortex	cortisol		
	aldosterone		
thyroid	thyroxine		

Are you gaining an appreciation for the many functions in your body controlled by hormones?

Check your answers by turning to the Appendix, Section 1: Activity 2.

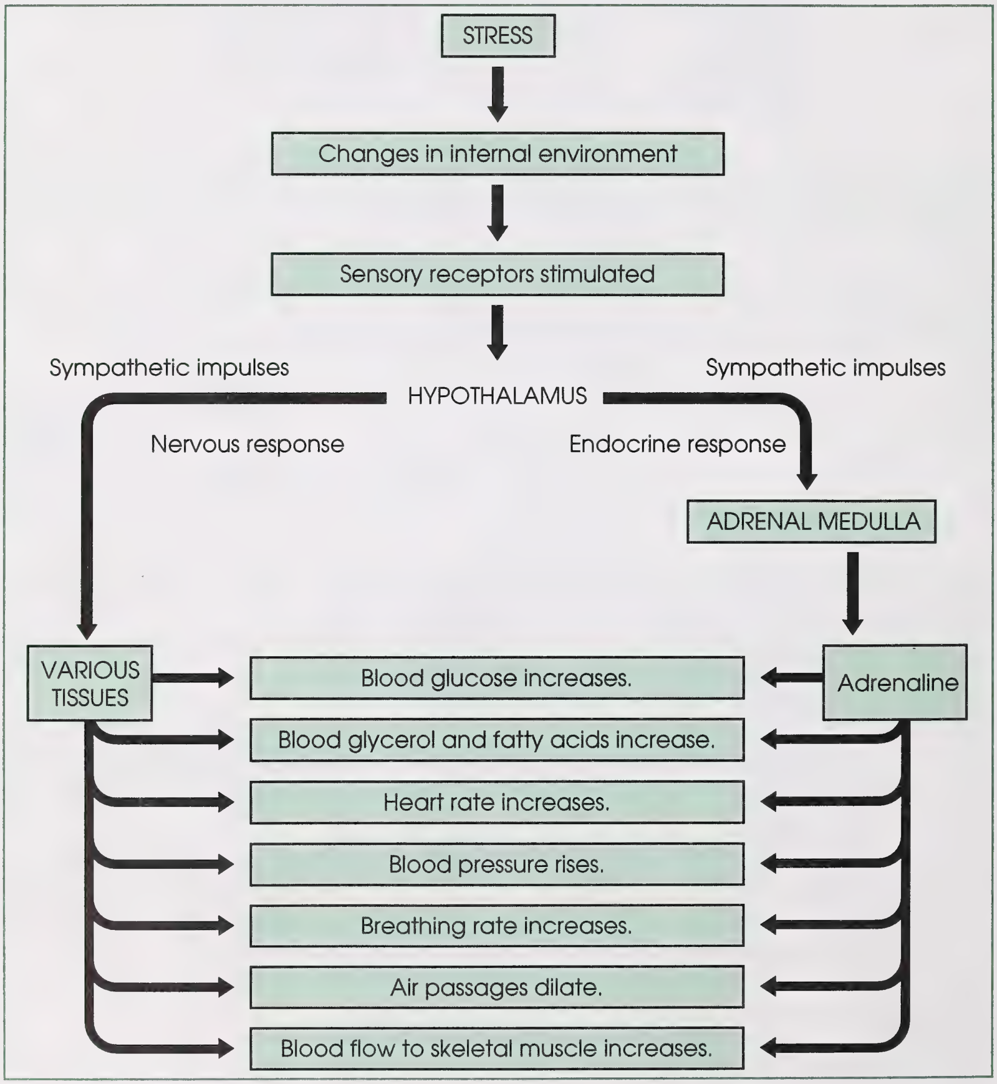
You may have noticed that most of the hormones in the table are relatively slow acting. For example, growth hormone is active in your body over several years. Other hormones like insulin are active over a period of minutes or hours. However, two hormones are active in just seconds. They are adrenaline and a very similar compound, noradrenaline. These are the stress hormones. Notice that adrenaline is also called epinephrine.

Stress

stress – the condition which results when you are exposed to an external stimulus (psychological or physical) which disrupts your internal environment

How do some of these hormones work when your body experiences **stress**? The body's general response to stress in an attempt to restore homeostasis is known as general adaptation syndrome (GAS) or general stress syndrome. This response was discovered by Hans Selye, an Austrian physician, who is generally recognized as the "father" of stress research.

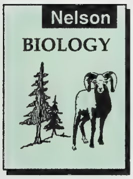
The following flowchart illustrates part of the response to stress.



Use this flowchart and information in your text to answer these general questions.

2. How does the body respond to stress with regards to digestion, heart rate, breathing, and blood pressure?
3. What are the reactions to stress collectively called?
4. Which branch of the nervous system controls the endocrine glands?
5. Identify the hormones released from the adrenal glands.
6. List five effects on the body when adrenaline is released.
7. What is the flight-or-fight hormone?

Check your answers by turning to the Appendix, Section 1: Activity 2.



8. Using the following format, construct a table identifying and summarizing the main hormonal and nervous components of general adaptation syndrome.

Nervous Components	**Function or Effect**
Hormonal Component	

9. Provide a description of general adaptation syndrome.

Check your answers by turning to the Appendix, Section 1: Activity 2.

The word *syndrome* is usually associated with a disease or disorder characterized by several different symptoms forming a pattern. General adaptation syndrome is not a disorder but involves a set of reactions required for maintaining a state of homeostasis in response to stress. However, problems do occur with the endocrine system if the various glands fail to function properly. In many cases this dysfunction has a genetic basis. In other cases it may be due to environmental effects or simply aging.

In certain individuals, an imbalance in hormone levels occurs. The condition of an insufficient amount of hormone being secreted is called hyposecretion. Hypersecretion occurs if there is too much hormone secreted. To examine the consequences of hyposecretion and hypersecretion of various hormones in the body, read the sections entitled Growth Hormone on page 338, Thyroid Gland on pages 344 and 345, and Thyroid Disorders on page 345. When completed, answer the following questions.

10. Do textbook questions 7 and 8 on page 341 of your text.
11. Do Review question 15 on page 346 of your text.
12. Do Review question 17 on page 347 of your text.

Control of Control Substances

While the production of hormones is critical to homeostasis, too much or too little of a good thing can be harmful. Hormones have to be controlled. The most common control mechanism is known as a feedback loop or negative feedback control. Numerous negative feedback systems exist in the body. Examine Figure 14.10 on page 339 in your text.

13. Describe how cortisol participates in the negative feedback loop.

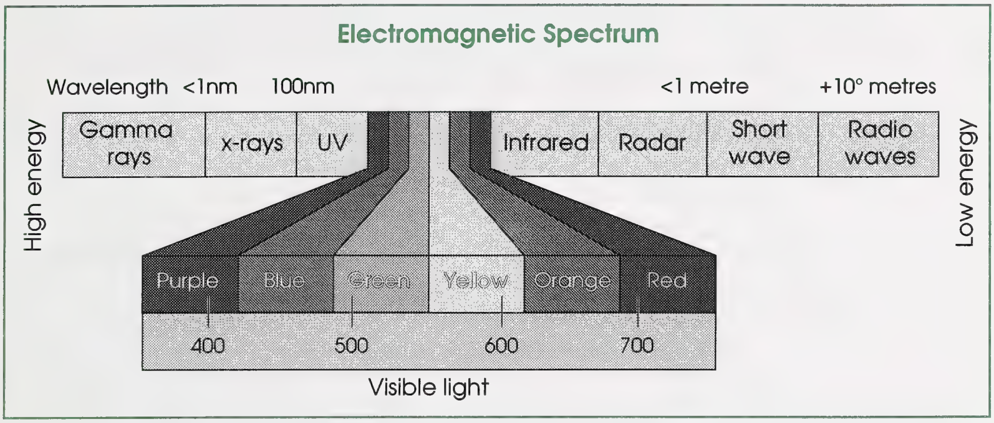
Check your answers by turning to the Appendix, Section 1: Activity 2.

In this activity you have examined the roles of a variety of hormones found in the body. The strong connection between the nervous system and the endocrine system has been reinforced. The two systems work together to keep your body in equilibrium. These ideas should reinforce the notion of how intricate your body is and the amazing way it keeps order. Can you imagine if your body did not have any homeostatic mechanisms?

ACTIVITY 3 Sun and Skin

Imagine the following: You're lying on the beach on a hot summer day with a breeze blowing across your body. It is so hot you think you might bake like a potato. At one time, this scene created pleasant thoughts and memories for most people. In fact, it was a means to a healthy-looking body. Today, however, people are more cautious when they are sitting out in the hot sun. With continued depletion of the ozone layer, exposure to ultraviolet light is creating a problem. In this activity you will investigate the interrelationship between ultraviolet (UV) light, ozone depletion, pigment deposition within skin cells, and the role of the endocrine system.

The wavelengths of light hitting the Earth range from high-energy gamma rays (short wavelength) to low-energy radio waves (long wavelength). Ultraviolet light is high-energy solar radiation. It is invisible to the human eye. Its position in the electromagnetic spectrum is shown in the following illustration.


Electromagnetic Spectrum

Ultraviolet light is beneficial in that it helps your skin produce vitamin D, which promotes bone formation and increases absorption of calcium. It is responsible for tanning your skin and for burning it. Continued exposure to ultraviolet light also increases your chances of skin cancer. The body's defence against ultraviolet light is the pigment melanin. Melanin is the chemical which gives your skin colour. It also absorbs UV light that passes through the skin.

PATHWAYS

If you have access to laboratory facilities, do Part A. If you do not have access to laboratory facilities, do Part B.

Part A

Investigation: Ultraviolet Light

Objective

The objective of this investigation is to design an experiment to demonstrate how an environmental factor, ultraviolet light, can be detected.

Materials

The following materials are needed to complete this investigation. Be sure to sterilize the pipets, toothpicks, and test tube with cap before beginning the investigation.

- G948-1C UV sensitive yeast
- 50 mL sterile water
- 2 1-mL pipets
- 6 toothpicks
- heavy paper, dark tape, or other lightproof material to shade half of plate
- sunscreens of various SPF values
- glass microscope slide, sunglasses, or other material to be tested for its ability to absorb UV
- tape (1.5 cm)
- test tube with cap
- 2 YED agar plates in petri dishes
- alcohol wipe
- personal protective equipment such as a sun hat, sunscreen, and sunglasses

Procedure

- Sterile (Aseptic) Technique:

  Sterile technique is essential to keep contaminants from ruining your experiment. It is quite simple if you follow two rules.

  Rule 1: Sterilize everything that will come in contact with the yeast.

  Rule 2: Once something is sterile, keep it sterile by not letting it touch anything that isn't sterile.

  To make materials sterile, you must heat them enough to kill all microorganisms. To keep materials sterile, start by wiping your hands and work space with an alcohol wipe. Since most contamination is airborne, avoid drafts and refrain from talking.

- Using a sterile technique, make a heavy suspension of yeast cells in a small volume (25-30 mL) of sterile water in the jar by gently scraping up some of the growing culture of G948-1C cells with the blunt end of a toothpick. Wipe the cells onto the inside of the container. Replace cover. Swirl to suspend the cells. Add cells until the suspension looks milky.

Science Skills

☐ A. Initiating
☐ B. Collecting
☑ C. Organizing
☑ D. Analysing
☑ E. Synthesizing
☐ F. Evaluating

1. The remainder of the procedural steps are in a scrambled sequence. To practise the science skill of designing experiments, put the steps in the correct order.

    a. Allow the agar to absorb the liquid containing the yeast for about ten minutes or until the liquid disappears.

    b. Expose the plates to direct sunlight in a sunny outdoor location for five to ten minutes. Place a paper or card under the plates to show a shadow to help you aim the plate directly at the sun, making sure that the surface of the agar will be perpendicular to the sun's rays. At this position, the shadow will be the smallest. The purpose of this is to get maximum exposure of UV light.

    c. Using the pipette, measure 0.9 mL of sterile water into a small capped test tube. Add 0.1 mL of the suspension from the jar to the 0.9 mL of water in the tube.

    d. Incubate the plates in a dark area at room temperature for three days.

    e. Cover half of the lid with a card, opaque tape, or lightproof envelope to block out ultraviolet light. Leave the other half, allowing it to be totally exposed.

    f. Pour the contents of the test tube onto the YED agar plate. Prepare another test tube of suspension and place onto another YED agar plate.

    g. Cover the halves of another YED plate with two other UV-absorbing materials such as sunscreen(s) of different SPF factors.

    h. Secure the lid to the bottom of the petri dish using a small piece of tape on the side of a dish. (The plastic lid of the petri dish does not absorb a significant amount of the UV-B found in sunlight, but the tape will.)

    i. Replace the lid of the plate to maintain sterility, and tilt and rotate it to spread the cells in a "lawn" over the surface of the agar. If there are places the liquid did not cover, use the blunt end of a toothpick to guide the suspension to cover those areas. The uniform distribution of the yeast cells is very important to the success of this lab.

    j. After the incubation period, record your observations.

Check your answers by turning to the Appendix, Section 1: Activity 3.

Observations

2. Using an appropriate table, record your observations (sketches or written) pertaining to the objective of the lab.

Analysis and Interpretation

3. Identify the manipulated and responding variables in this experiment.

4. State the control used in this experiment.

5. List two controlled variables in this lab activity.

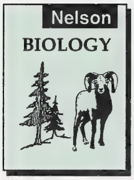
6. How were you able to detect the presence of ultraviolet light in the experiment?

7. With regards to absorption of ultraviolet light, how were you able to determine the effect of the different materials used?

8. Which material, other than your control, blocked out the most ultraviolet light? How could you tell?

Check your answers by turning to the Appendix, Section 1: Activity 3.

Application



Hopefully you have been able to see that sunscreen lotions do play a significant role in blocking ultraviolet light. To examine the relationship between UV light, ozone depletion, and pigment deposition with skin cells, review the section entitled Holes in the Ozone Layer on pages 23 and 24.

9. Explain the relationship between ozone depletion and ultraviolet light.

10. The text mentions that possibly 60% of the ozone layer could be destroyed by the middle of the next century. Using this value, what would be the predicted percentage increase in skin cancer?

Check your answers by turning to the Appendix, Section 1: Activity 3.

Part B

Read through the following Canadian Cancer Society pamphlet *Sun Sense* and answer the questions.

CANADIAN CANCER SOCIETY | **SOCIÉTÉ CANADIENNE DU CANCER**

RISK

You're at greatest risk if ...

- You work or play for long periods outdoors.
- You are a blond or a redhead who burns easily.

Fair-skinned people don't have enough colour pigment in their skin to stop the sun's burning rays.

That **PINK/RED** burn is a sign of skin damage. The damage doesn't go away but builds with each sunburn

THAT CAN LEAD TO CANCER

SUN SCREENS

- Look for a sunscreen with an SPF factor of 15 or higher and one that will block both UV-A and UV-B rays.

  Apply evenly to all exposed areas, 15-30 minutes before you go out.

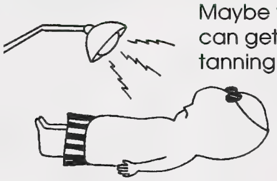
  Reapply every 3 or 4 hours, or after each swim.

The higher the SPF number the greater the protection

But remember ...

NO SUN SCREEN ABSORBS ALL THE SUN'S RAYS. IF YOU STAY OUT LONG ENOUGH YOU'LL BURN.

TANNING PARLOURS



Maybe you've heard you can get a "safe" tan in a tanning parlour?

THINK AGAIN!

Suntanning machines produce the same wave length of light as the sun and ...

CAUSE THE SAME DAMAGE

The sun is the main cause of skin cancer, and skin cancer is the most common cancer in Canada. But the cure rate is 95%.[1]

---

[1] The *Canadian Cancer Society* adapted from the brochure "Sun Sense" Revised April 1993 edition. *Canadian Cancer Society*.

PROTECTION

It's easy to protect yourself ...

- Wear a wide-brimmed hat
- And a loose-fitting long-sleeved shirt
- And long pants

USE A SUN SCREEN

MALIGNANT MELANOMA

Malignant melanoma is the most serious form of skin cancer and causes most skin cancer deaths.

SEE A DOCTOR IF ...

- You find any new or changing bluish-black or dark brown growth.
- The growth itches or bleeds.

Malignant melanoma spreads quickly **but** can be cured if treated early.

SO IT PAYS TO BE SUSPICIOUS!

SYMPTOMS

It's not too late ...

You can still change old habits! If you see something suspicious SEE YOUR DOCTOR.

This can include:

- A spreading skin growth (it may be pearly, tan, brown or black but any spreading growth should be checked).
- A mole, birthmark or beauty spot that changes or has an odd shape.
- An open sore that doesn't heal. It could be trouble if ignored.

Remember: Quick treatment almost always means a

LONG LASTING CURE!

- SLIP on clothing to cover your arms and legs.
- SLAP on a wide-brimmed hat.
- SLOP on a sunscreen with SPF-15 or higher.

Skin cancer can be beaten!
15

Sunlight reflected from water or snow can also be dangerous. Protect yourself both summer and winter by following the above suggestions.[1]

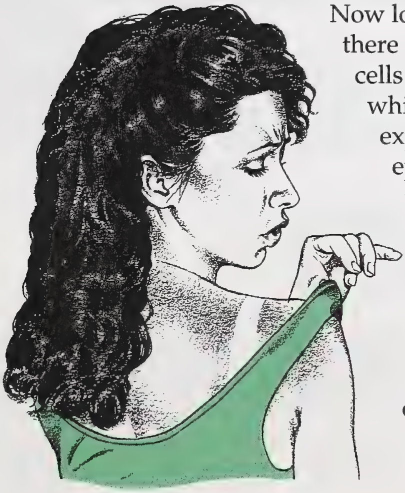
---

[1] The *Canadian Cancer Society* adapted from the brochure "Sun Sense" Revised April 1993 edition. *Canadian Cancer Society*.

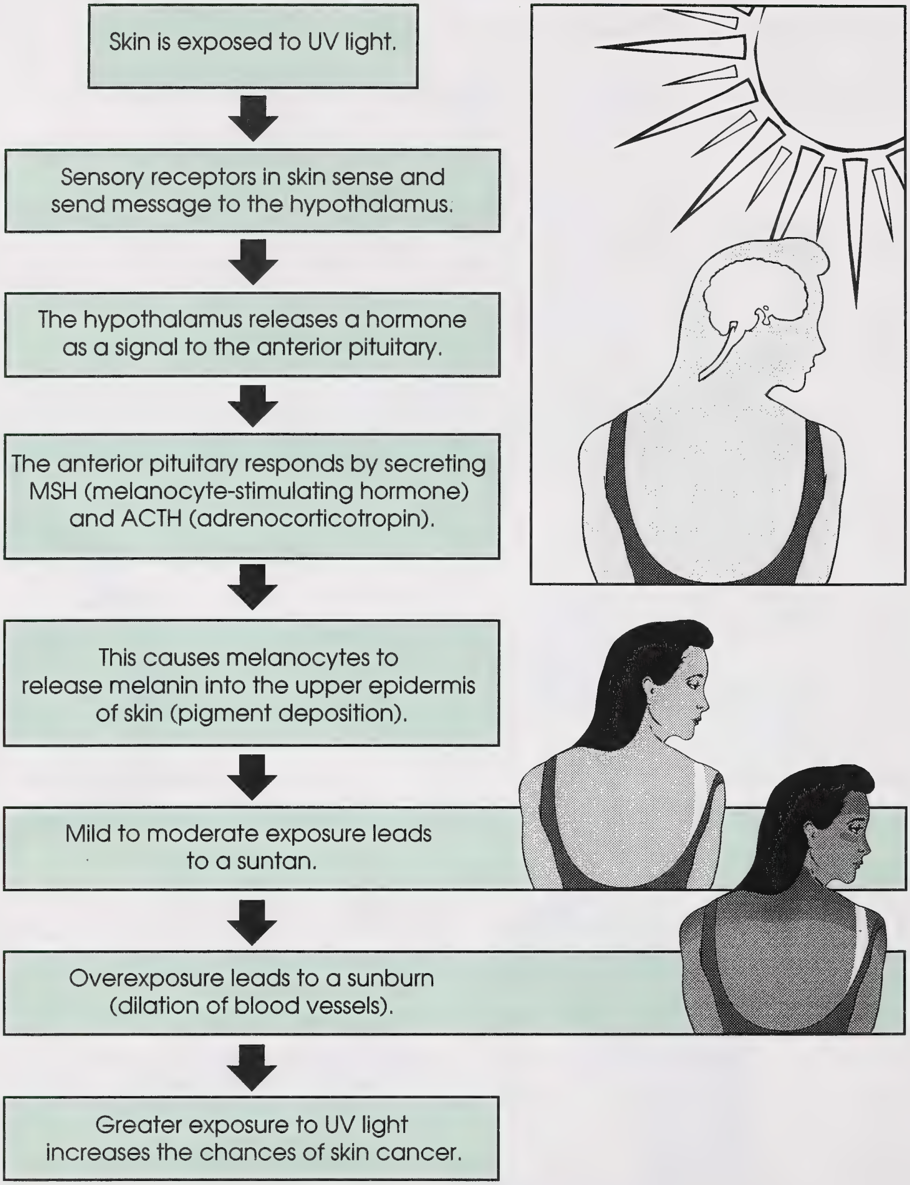
11. Why do fair-skinned people tend to sunburn easily?
12. What SPF factor is considered to be the lowest acceptable for protection?
13. What kind of ultraviolet rays are blocked by SPF sunscreens?
14. Why are suntanning machines as dangerous as natural sunlight?
15. Describe some other protective measures you can use to avoid sunburn.
16. Describe several possible signs of early skin cancer.
17. How can snow increase the severity of sunburn?

Check your answers by turning to the Appendix, Section 1: Activity 3.

In Canada each year there are approximately 45 000 new cases of skin cancer. It is the fastest growing cancer in Alberta and in the rest of Canada.



Now look at the details of skin cancer. Just below the skin, there are specialized cells known as melanocytes. These cells are responsible for producing the pigment melanin, which determines the colour of your skin. When exposed to sunlight melanin is released into the upper epidermis of the skin (pigment deposition) to absorb the ultraviolet light and protect your skin. Melanin acts as a natural sunscreen. Prolonged exposure to UV radiation damages or kills more and more cells in the skin. This eventually leads to a sunburn. The visual appearance of a sunburn is due to blood vessels in the skin which have dilated. The following flowchart illustrates the series of events along with the hormones involved.



Skin is exposed to UV light.

Sensory receptors in skin sense and send message to the hypothalamus.

The hypothalamus releases a hormone as a signal to the anterior pituitary.

The anterior pituitary responds by secreting MSH (melanocyte-stimulating hormone) and ACTH (adrenocorticotropin).

This causes melanocytes to release melanin into the upper epidermis of skin (pigment deposition).

Mild to moderate exposure leads to a suntan.

Overexposure leads to a sunburn (dilation of blood vessels).

Greater exposure to UV light increases the chances of skin cancer.

Note: ACTH is structurally similar to MSH but the quantity of ACTH released is much greater than MSH. For this reason, ACTH may be more important than MSH in controlling release of melanin.

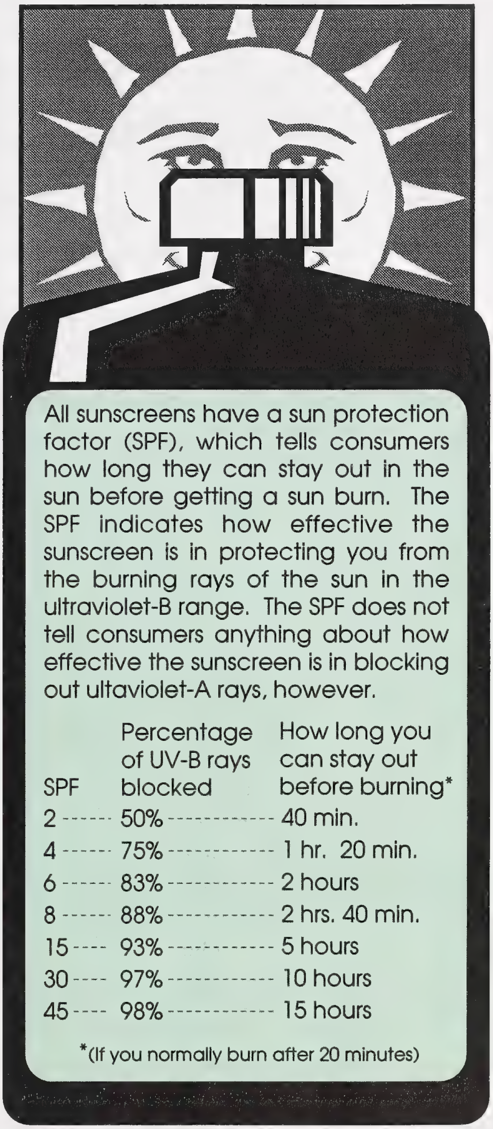
The cumulative effects of exposure to sunlight increase the chances for the ultraviolet light to damage the melanocyte cells or other actively dividing cells in the skin to the extent that they begin dividing at an uncontrolled rate. This is skin cancer.

In a later module you will learn more about the cellular aspects of cancer when you study a type of cell division known as mitosis. To reduce the chances of skin cancer, care and moderation should be exercised when outside in the sun.

18. From a physiological perspective, explain the function of sunscreens in preventing sunburns.

19. Explain the relationship between ultraviolet light and pigment deposition within the skin cells.

Ultraviolet light is becoming a more significant factor affecting the lives of humans. With depletion of the ozone layer, more ultraviolet light is reaching the Earth's surface. You have studied some of the consequences of exposure to ultraviolet light. You have a decision to make: continue unprotected exposure to the sun and increase the risk of skin cancer, or take the proper precautions – avoiding unnecessary exposure, wearing protective clothing, and wearing a sunscreen – and decrease the chances of skin cancer. Will you make the right decision?



All sunscreens have a sun protection factor (SPF), which tells consumers how long they can stay out in the sun before getting a sun burn. The SPF indicates how effective the sunscreen is in protecting you from the burning rays of the sun in the ultraviolet-B range. The SPF does not tell consumers anything about how effective the sunscreen is in blocking out ultaviolet-A rays, however.

SPF	Percentage of UV-B rays blocked	How long you can stay out before burning*
2	50%	40 min.
4	75%	1 hr. 20 min.
6	83%	2 hours
8	88%	2 hrs. 40 min.
15	93%	5 hours
30	97%	10 hours
45	98%	15 hours

*(If you normally burn after 20 minutes)

[1]

Check your answers by turning to the Appendix, Section 1: Activity 3.

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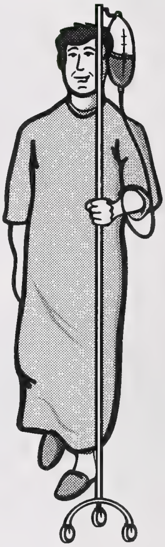
[1] *The Edmonton Journal* for the chart "Sunscreen" by Keith Kobyika, June 21, 1993. Reprinted by permission of *The Edmonton Journal*.

ACTIVITY

4 Regulation of Glucose Metabolism

intravenous – a medical procedure where a fluid is allowed to drain directly into a vein

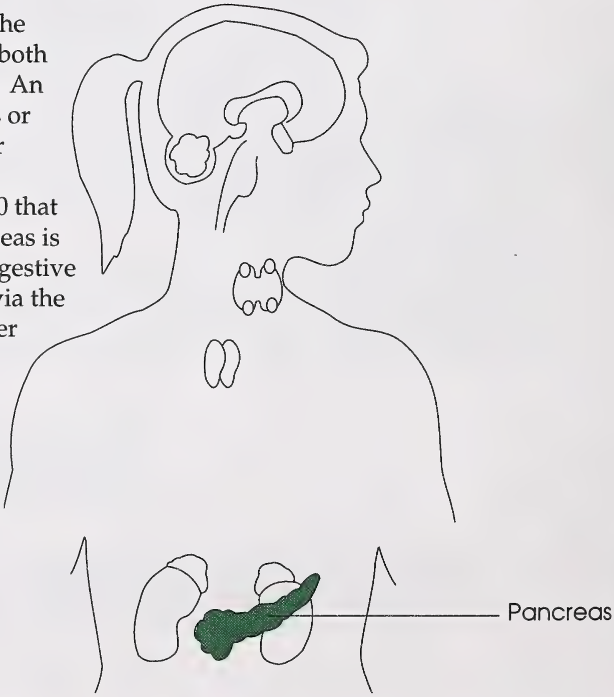
Have you ever seen a patient in a hospital on intravenous? A bag of colourless fluid hangs on a pole and has a tube at the end which goes into the patient. What is in the fluid?



Glucose is a common component of intravenous fluid. Its purpose is to provide energy for the body. Notice however that the glucose would not be entering the body through the digestive system but rather going directly into the blood. How is blood glucose used? The answer involves the action of a very important hormone and its careful regulation. This regulation is a vital homeostatic mechanism since glucose serves as a major fuel for cellular respiration and is required for the synthesis of other important organic compounds. The hormone is insulin which is made in the pancreas. Before getting into the details of insulin and hormonal regulation of glucose metabolism, there is some background information you should know about the pancreas and the control mechanism of negative feedback.

The Pancreas

The pancreas is the key gland in the regulation of blood glucose. It is both an endocrine and exocrine gland. An exocrine gland secretes into ducts or tubes leading to target sites rather than into the bloodstream. You should remember from Biology 20 that the exocrine function of the pancreas is to secrete bicarbonate ions and digestive enzymes into the small intestine via the pancreatic duct. Examples of other exocrine glands include the salivary glands and the sweat glands. The endocrine function of the pancreas is concerned with maintenance of proper blood glucose levels in the body. Endocrine glands secrete their substances directly into the blood stream. The blood then carries the substances to target organs.



Carefully read about the endocrine role of the pancreas on page 340 in your text. Answer the next questions.

1. What structures in the pancreas serve an endocrine function?
2. What are the two hormones produced by the endocrine cells?
3. a. Which hormone would be secreted by the pancreas after a large meal?

   b. Which hormone would be secreted in the morning if you decided to go jogging before breakfast?

Discoveries of control substances in the body are good examples of scientific research. The secretions of the pancreas are no exception.

Read about some early research into the function of the pancreas on page 333. This research was done in 1899.

4. Predict why glucose would be present in the urine of dogs after removal of the pancreas. Infer the role of the kidneys in your answer.

At the conclusion of the research by von Merring and Minkowski, a chemical messenger from the pancreas was implicated in controlling blood glucose, but the actual discovery of the substance would not occur for another twenty years.

Read about the discovery of insulin on page 342 in your text.

5. Why was insulin initially difficult to identify in pancreatic tissue?
6. Describe the consequences for all metabolism if glucose is detected in the urine.

Check your answers by turning to the Appendix, Section 1: Activity 4.

To examine the relationship between insulin and blood glucose, you will perform the following investigation. Briefly read over the investigation to get an overview of what you'll be doing.

Science Skills

☐ A. Initiating
☑ B. Collecting
☑ C. Organizing
☑ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

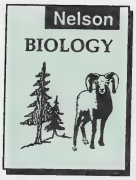
Investigation: Identification of Hyperglycemia

Background Information

Before doing the lab, some background information and a review of the excretory system will give you a better understanding of the lab activity. You may refer to Chapter 13 of the text to help answer the following questions.

7. State the general function of the excretory system.

8. To what does the composition of urine relate?



9. a. Describe the relationship between the terms *glucose*, *monosaccharide*, and *reducing sugar*. If necessary, refer to Background Information on page 163 of the text.

   b. Compare urine from a non-diabetic person to urine from a person with untreated diabetes if both urine samples were subjected to a Benedict's test.

It should be noted that normal healthy individuals do not usually have glucose in their urine, whereas it is present in the urine of diabetics. With this background information, you are now ready to do the lab.

Check your answers by turning to the Appendix, Section 1: Activity 4.

Materials

- 4 Multistix
- water*
- paper towel*
- 4 test tubes
- colour chart
- simulated urine Sample Y
- simulated urine Sample X
- tape to label test tubes*
- graduated cylinder (10 mL)
- container to hold test tubes*
- 1/8 teaspoon corn sugar

* supplied by student

Procedure

- Label the test tubes *A*, *B*, *C*, and *D*.
- Add 7 mL of water to test tubes A and B.
- Carefully add 1/8 teaspoon of corn sugar to Test Tube B. Gently mix the sugar to dissolve.
- Test the water in each test tube with a separate Multistix. Dip the Multistix fully into the sample; then remove and place on a paper towel. Look for any changes in the Multistix pads compared to the colours on the chart.
- Record the glucose level for each test tube.
- Add 7 mL of simulated urine Sample X to Test Tube C.
- Rinse out the graduated cylinder.

- Add 7 mL of simulated urine Sample Y to Test Tube D.
- Test each urine sample with a Multistix.

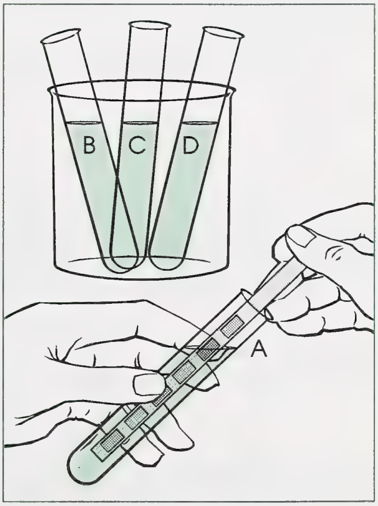
Notice the other possible tests on the Multistix chart. Compare any of these test results to plain water. These tests are used in medical clinics.

Rinse out the test tubes and discard the Multistix.

Observations

Record the results of your tests on a table similar to this.

Test Tube Sample	Glucose
A	
B	
C	
D	



Analysis and Interpretation

10. Which test tube samples would be representative of a normal healthy individual? Explain your answer.

11. Which test tube samples would indicate an individual with diabetes? Explain your answer.

Science Skills

☐ A. Initiating
☐ B. Collecting
☐ C. Organizing
☑ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

Application

Nelson BIOLOGY

12. Answer Application questions 1 to 4 on page 343.

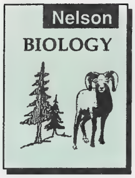
You may wish to refer to page 341 in your text for more information.

13. Based on the results of this experiment, establish the relationship between blood glucose, presence of glucose in the urine, and insulin in individuals who have diabetes mellitus which is not controlled.

14. Explain the absence of glucose in the urine of normal individuals with reference to blood glucose and insulin concentrations.

Check your answers by turning to the Appendix, Section 1: Activity 4.

The Role of Glucagon in Glucose Metabolism

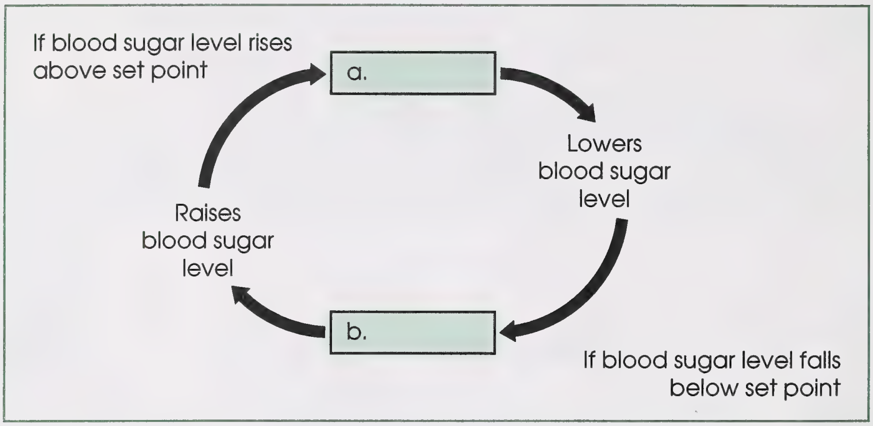


Another hormone involved with glucose metabolism is glucagon. Use the information from pages 340 and 341 in your text to answer the following questions.

15. Identify two ways in which insulin decreases blood glucose levels.

16. How does glucagon increase blood glucose levels?

17. Identify the hormones secreted in the following homeostatic loop.


If blood sugar level rises above set point
a.
Lowers blood sugar level
b.
If blood sugar level falls below set point
Raises blood sugar level

18. Describe the usual cause of diabetes mellitus.

19. List three symptoms associated with diabetes mellitus.

20. Why do individuals with diabetes mellitus experience low levels of energy even though they have high blood glucose levels?

21. Besides age of onset, what is the difference between juvenile diabetes and adult diabetes? Are insulin injections used to treat both types of diabetes? Explain.

Check your answers by turning to the Appendix, Section 1: Activity 4.

Diabetes mellitus is not the same as diabetes insipidus, which you may remember from Biology 20. Do not confuse the terms *glucose*, *glycogen*, and *glucagon*.

In this activity you have studied the regulation of blood glucose in the body. Maintaining the proper amount of glucose in the blood is dependent on the presence of the hormones insulin and glucagon. Proper blood glucose levels ensure that you have enough energy to carry out metabolic activities in your body and that you do not deplete your energy supplies. Maintaining energy requires the coordination of control and secretion.

ACTIVITY

5 Osmoregulation

Nelson BIOLOGY

Have you noticed a difference in your urine first thing in the morning compared to later on in the day? Usually, your urine in the morning is more yellow (more concentrated) than later on in the day. Why does your urine have these different characteristics? Does this reflect a control system somewhere in your body? In this activity you will study antidiuretic hormone (ADH) and aldosterone, which play an important role in maintaining body fluid levels. Both hormones are associated with the excretory system of your body. Study the functions of these hormones by reading pages 320 to 325 in your text.

1. Using your text or other references available to you, define the term *diuretic* and provide some examples of diuretic substances.

2. What is an antidiuretic?

Check your answers by turning to the Appendix, Section 1: Activity 5.

Antidiuretic hormone (also known as vasopressin) is produced in the hypothalamus and stored in the anterior pituitary. To determine the role of this hormone, you will examine some data relating to the composition of urine in five subjects.

Subject	Glucose in Urine (%)	Protein in Urine (%)	Urine Output (L/day)
A (normal)	0.0	0.0	2
B	0.1	0.0	4
C	0.0	2.0	6
D	0.0	0.0	1
E	0.0	0.0	6

Science Skills

☐ A. Initiating
☐ B. Collecting
☐ C. Organizing
☑ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

3. Which subject would you expect to have higher-than-normal levels of antidiuretic hormone? Explain your answer.

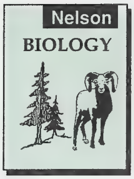
4. On the basis of urine output alone, which subjects may you suspect to have low levels of antidiuretic hormone? Explain your answer.

5. Antidiuretic hormone influences the quantity of output. In subjects indicated for question 4, what is the key substance found in the urine which accounts for the differences in urine output?

6. a. From the information in question 5, identify the subject who probably suffers from low levels of antidiuretic hormone. Explain your answer.

   b. Provide reasons why the other two subjects you identified in question 4 have increased urine outputs.

7. Based on what you have learned from the previous questions, state and explain the function of antidiuretic hormone.



8. Do Review questions 7 to 11 on page 324 of your text.

Check your answers by turning to the Appendix, Section 1: Activity 5.

Pain, anxiety, drugs (morphine, nicotine, tranquillizers), trauma to the body, and some anaesthetics can also increase the release of antidiuretic hormone.

Aldosterone is a hormone produced in the adrenal cortex of the adrenal glands. Refer to the description of aldosterone on pages 322 and 323 and use the information on the following table to answer the next questions.

Aldosterone Secretion	Na^+ in Plasma (mEq/L)	Blood Pressure
normal	142	normal
below normal	120	below normal
above normal	148	above normal

Science Skills

☐ A. Initiating
☐ B. Collecting
☐ C. Organizing
☑ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

9. Based on the data, make conclusions about the effects of below-normal secretions of aldosterone on sodium ion concentration and blood pressure.

10. Establish and explain the relationship between sodium ion concentration in the plasma and blood pressure when there is above-normal secretions of aldosterone.

11. Using the information from the two previous questions, state the functions of aldosterone with respect to osmoregulation.

Check your answers by turning to the Appendix, Section 1: Activity 5.

12. Discuss the relationship between aldosterone, sodium ion reabsorption, osmotic pressure, and blood pressure.

13. State the function(s) of renin and angiotensin.

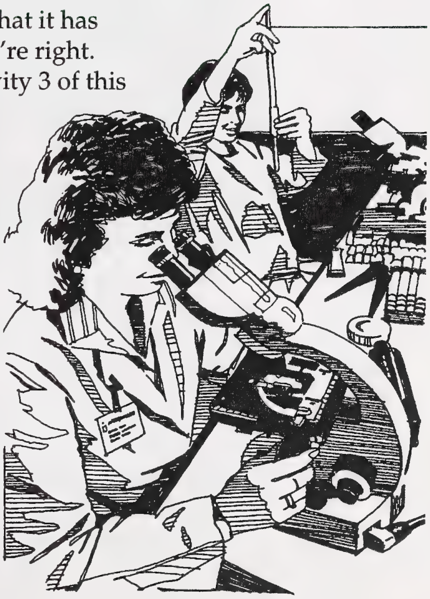
14. Where in the nephron does aldosterone carry out its function?

Check your answers by turning to the Appendix, Section 1: Activity 5.

Now you can see that both antidiuretic hormone and aldosterone play an important role by increasing water reabsorption. However, it is important to realize that each hormone responds to a different stimulus. Antidiuretic hormone responds to increases in osmotic pressure in the blood. This would occur in cases of dehydration. Aldosterone, on the other hand, is released when there is a loss in blood volume (decreases blood pressure) but there is no increase in osmotic pressure. This may occur when an individual suffers an injury and is bleeding or has severe diarrhea. In this activity you have examined the roles of antidiuretic hormone and aldosterone. They both act together in maintaining a homeostatic state in your body.

ACTIVITY

6 Hormones and Biotechnology



Do you know what biotechnology is? If you said that it has something to do with biology and technology, you're right. Biotechnology has become a big business. In Activity 3 of this section you worked with one of the products of biotechnology. Through biotechnology, the yeast strain used in the investigation was altered to become UV sensitive. Another good example would be the Multistix you used to test for glucose. At one time, diabetes mellitus was detected by taste. Obviously a better technology was needed. In this activity you will explore this fascinating scientific field looking specifically at how this technology has affected various aspects of the endocrine system.

Nelson
BIOLOGY

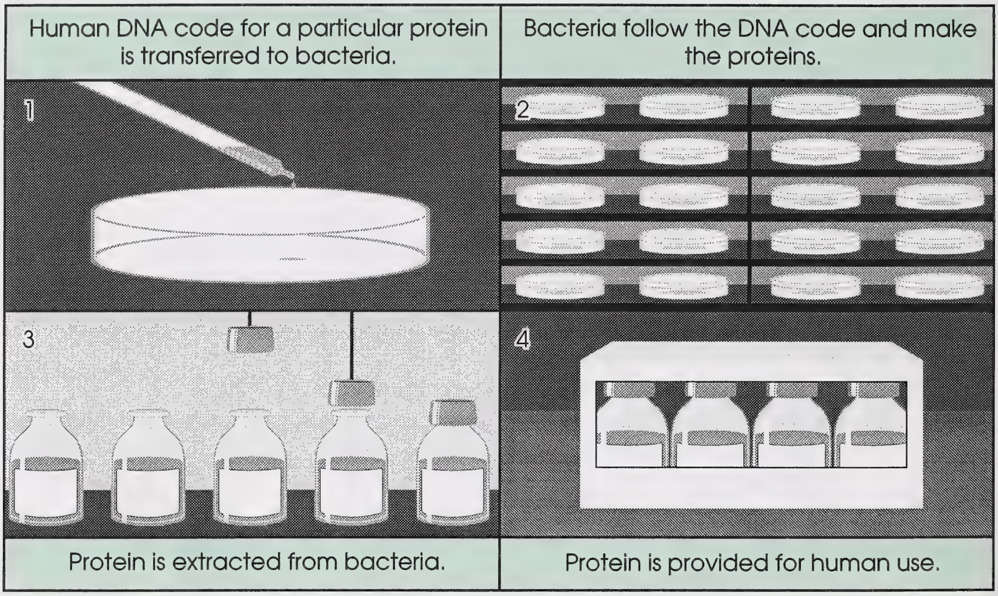
To introduce the concept of biotechnology, read the section on DNA and Industry on pages 528 to 529 of your text. Use the information from the reading to answer the following questions.

1. Provide a description of biotechnology.

2. Provide examples of organisms that have been used in biotechnology.

Biotechnology is not a new science. It has been around for a long time. You can think of the making of wine and cheese from microorganisms as biotechnology. The selective mating of different organisms to produce preferred or different offspring could also be considered biotechnology. The big explosion in biotechnology in the 1980s and 1990s is because of advancements in DNA technology. DNA is a nucleic acid found in the nucleus of the cell which contains the instructions for making proteins. This substance is the reason why the nucleus is referred to as the control center or "brain" of the cell. You'll learn more about DNA and its significance in Module 5.

In simple terms, DNA technology involves the location and manipulation of genetic material (genetic engineering). A general scheme for this process involves the following:


Human DNA code for a particular protein is transferred to bacteria.
Bacteria follow the DNA code and make the proteins.
1
2
3
4
Protein is extracted from bacteria.
Protein is provided for human use.

Using DNA technology, scientists have been able to improve the quality of life for the human species. DNA technology has been used to produce bovine growth hormone, human growth hormone, and human insulin.

Bovine Growth Hormone (BGH)

Biotechnology has been used for agricultural purposes in an attempt to increase production of various substances. Bovine growth hormone is a newly designed hormone, produced by bacteria (*Escherichia coli*), which is injected into dairy cows in an attempt to improve milk production. Studies have indicated that milk production increases by about 10%. It has also been found that BGH increases the weight of beef cattle.

3. From a global perspective, how can BGH benefit the human species?

Human Growth Hormone

As indicated in a previous activity, hyposecretion of growth hormone during childhood results in pituitary dwarfism. Before the advances in DNA technology, treatment for this condition was difficult and expensive. To treat an individual with dwarfism, growth hormone had to be obtained from human cadavers. Since 1985, human growth hormone has been produced by bacteria and has helped in treating individuals with this form of dwarfism.

A negative aspect to the production of human growth hormone is that certain athletes are using it to increase muscle mass in their bodies. The problem with this is that it upsets the natural balance in the body and results in harmful side effects.

Human Insulin

People with diabetes mellitus may require daily injections of insulin. As you have read in your text, insulin can be obtained from pigs and cattle.

4. Briefly describe one disadvantage to humans in using bovine insulin.

5. How has biotechnology improved the quality and quantity of insulin for humans?

Nelson
BIOLOGY

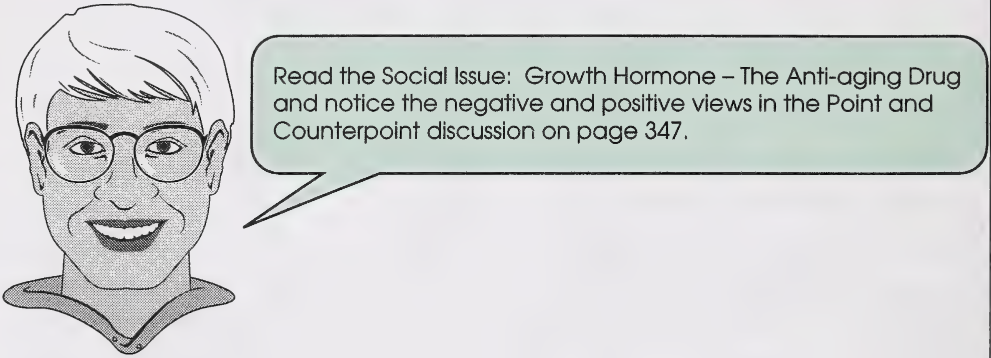
Another type of therapy used to treat diabetes mellitus is transplant therapy. To learn more about this type of therapy, read Frontiers of Technology: Islet Transplants on page 344 of your text.

6. Explain why insulin therapy and transplant therapy are not considered cures for diabetes mellitus.

Check your answers by turning to the Appendix, Section 1: Activity 6.

In this activity you have had an opportunity to explore the field of biotechnology in the 1990s. It has allowed for significant advancements in terms of treatments for endocrine disorders. It has opened new doors for research in various areas. It has been speculated that this research may extend your youth, increase your lifespan, change your personality, eliminate disease, and correct inherited disorders. It is important for the human species to use this technology with great care.

How do you feel when advances in science are used to alter "normal" individuals to suit their own personal tastes or needs? Scientists make these important discoveries, but society as a whole plays a major role in controlling the direction and application of the research.



Read the Social Issue: Growth Hormone – The Anti-aging Drug and notice the negative and positive views in the Point and Counterpoint discussion on page 347.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

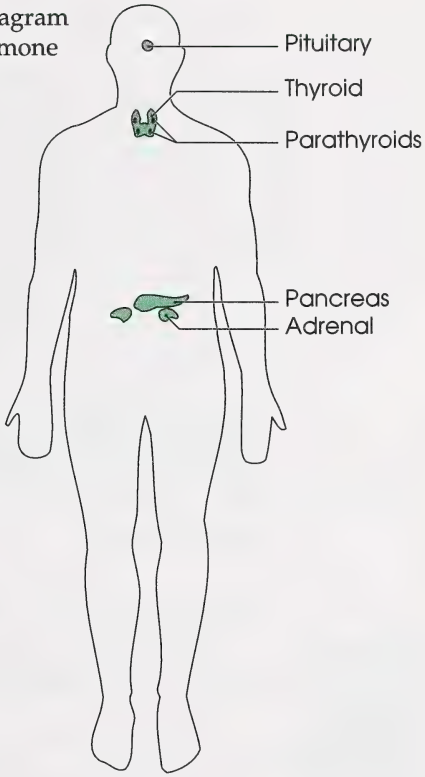
Extra Help

Do the following questions to review important concepts from Section 1.

1. For the following series of statements fill in the blanks with the appropriate term. Each blank should consist of one word.

   The endocrine system secretes substances known as _____a_____ which act as chemical _____b_____ throughout the body. The function of the endocrine system is to work with the _____c_____ system to maintain equilibrium or a state of _____d_____. The endocrine system secretes substances such as hormones directly into the _____e_____.

2. Using the following list of hormones and the diagram of the various glands, place the letter of the hormone beside the gland which secretes it.



a. thyroid-stimulating hormone

b. antidiuretic hormone

c. melanocyte-stimulating hormone

d. adrenaline

e. aldosterone

f. insulin

g. parathyroid hormone

h. human growth hormone

i. adrenocorticotropic hormone

j. thyroxine

k. noradrenaline

l. cortisol

m. glucagon

3. Match the hormone with its effect. Each hormone is to be used only once.

Hormone

a. thyroid-stimulating hormone
b. human growth hormone
c. antidiuretic hormone
d. adrenocorticotropic hormone
e. melanocyte-stimulating hormone
f. thyroxine
g. adrenaline/noradrenaline
h. aldosterone
i. cortisol
j. insulin
k. glucagon
l. parathyroid hormone

Effect

(i) increases water reabsorption
(ii) increases permeability of kidney cells glucose
(iii) promotes growth
(iv) promotes conversion of glycogen to glucose
(v) stimulates release of thyroxin
(vi) prepares body for stress by increasing heart activity (flight-or-fight hormone)
(vii) stimulates release of hormones involved in stress responses
(viii) plays a role in regulating release of melanin
(ix) increases the level of amino acids in the blood
(x) regulates metabolic activity
(xi) increases sodium reabsorption
(xii) stimulates calcium release from bone

4. For each of the following statements, indicate whether it is true or false.

   a. ______ Hypersecretion of insulin results in diabetes mellitus.

   b. ______ With ozone depletion, the amount of ultraviolet light you are exposed to increases and causes more melanin to be deposited into your skin cells.

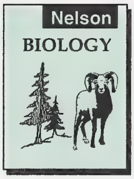
   c. ______ Biotechnology has allowed production of hormones which have been difficult to obtain in the past.

   d. ______ Negative feedback is a homeostatic mechanism which stimulates an increased production of product.

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

Do one or more of the following activities.



1. Read the section Chemical Signals on pages 334 and 335 in the text. Describe the differences and similarities between steroid hormones and protein hormones.
2. Do Critical-Thinking questions 1, 3, and 4 on page 349 of the text.
3. Do Critical-Thinking questions 1 to 3 on page 329 of the text.
4. Skin cancer is a growing concern in today's society. Collect newspaper clippings dealing with skin cancer, sunscreen lotions, ozone depletion, and ultraviolet light. With these clippings, make a collage using a central theme.
5. Two common diabetic emergencies are hypoglycemia and diabetic ketoacidosis (DKA). Research these two topics with respect to causes, symptoms, and treatment for these emergencies. To help you with this, contact the following addresses:

   The Canadian Diabetes Association
   Calgary and District Branch
   1207-11 Avenue, S.W.
   Calgary, Alberta
   T3C 0M5
   Tel: (403) 245-5959

   or

   Edmonton and District Branch
   #305, 10240-124 Street
   Edmonton, Alberta
   T5N 3W6
   Tel: (403) 488-4834

   Another resource is to consult your local doctor or hospital staff.

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

At the beginning of this section there was a photograph showing a possible emergency. You had probably heard of the hormone adrenaline before and had an idea of its effect. Another hormone you were probably familiar with was insulin. After completion of this section, you should have a better understanding of the metabolic roles of these hormones along with many other hormones in the endocrine system. You should have gained an understanding of how the endocrine system senses its internal environment and responds appropriately to it. You have studied the connection between the nervous system and the endocrine system and their important role in maintaining homeostasis. You were introduced to the advances in biotechnology with respect to breakthroughs concerning hormones. In the next section you will continue learning about the endocrine system but from a reproductive point of view.

60

Section 1 Assignment: Homeostasis and Chemical Control

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

Response Page Setup

Biology 30 – Module 2 Section 1 Assignment Page # Name and ID#

Be sure to write legibly. Leave a wide left margin and number all of your pages.

Carefully read each of the following multiple choice questions and decide which of the choices **best** completes the statement or answers the question. Each question is worth 1 mark.

1. Secretions from the endocrine glands are able to reach target organs because

   A. they are controlled by the pituitary
   B. the glands are situated throughout the body
   C. the hypothalamus directs hormone production
   D. hormones are secreted directly into the blood

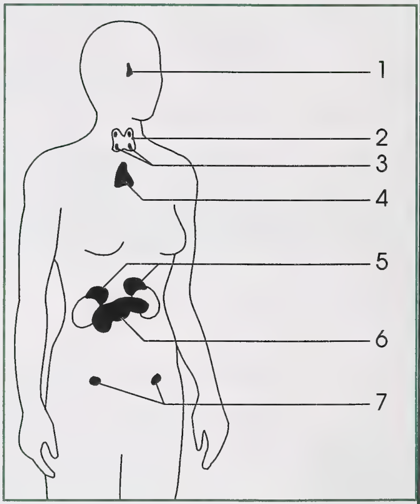
2. The endocrine system differs from the nervous system in that

   A. it usually reacts faster
   B. it usually has a more specific target area
   C. it usually has a longer lasting effect
   D. large quantities of chemicals are released

3. The part of the brain that has the greatest effect on the endocrine system is the

   A. hypothalamus
   B. medulla oblongata
   C. cerebrum
   D. cerebellum

Use the following diagram to answer questions 4 to 7.



4. The gland that functions in the **greatest** number of negative feedback systems is labelled

   A. 1
   B. 5
   C. 6
   D. 7

5. The major hormone produced from the gland labelled 2 would be used in treating overweight people because it

   A. decreases the appetite
   B. accelerates the conversion of glucose to glycogen
   C. inhibits the conversion of fatty acids and glycerol to fat
   D. increases the metabolic rate

6. The flight-or-fight response is due to hormones released by the gland labelled

   A. 3
   B. 5
   C. 6
   D. 7

7. The parathyroid glands are labelled as

   A. 1
   B. 3
   C. 6
   D. 7

8. Exposure to ultraviolet light causes pigment deposition within skin cells that acts

   A. to reflect ultraviolet rays
   B. to decrease ozone depletion
   C. to absorb ultraviolet light
   D. to increase ozone depletion

9. General Adaptation Syndrome can best be described as

   A. a disorder which is stress related
   B. the failure to adapt to a stressful situation
   C. a hormonal disorder
   D. a response to stress

10. An example of negative feedback would be the process by which

    A. nerves stimulate glands to produce hormones
    B. the accumulation of a hormone in the blood inhibits further production of that hormone
    C. the production of hormones is regulated by the autonomic nervous system
    D. unnecessary hormones are absorbed back into the gland that produced them

11. Under conditions of injury, fright, or stress, the body's response is to release

    A. melanin
    B. progesterone
    C. secretin
    D. adrenaline

12. The three hormones directly involved in glucose metabolism are

    A. thyroxin, adrenaline, and insulin
    B. insulin, aldosterone, and estrogen
    C. thyroxin, adrenaline, and aldosterone
    D. testosterone, thyroxin, and ADH

13. How would eating a meal very high in carbohydrates affect a person's blood glucose and insulin levels after sufficient time has been allowed for digestion and absorption to occur?

    A. Both glucose and insulin levels would be lower.
    B. Both glucose and insulin levels would be higher.
    C. Glucose levels would be unchanged while insulin levels would be higher.
    D. Glucose levels would be higher while insulin levels would be unchanged.

14. While watching a horror film, a person experienced an increased heart rate. This response was likely caused by increased activity of the

    A. sympathetic nervous system and increased secretion from the thyroid gland
    B. sympathetic nervous system and increased secretion from the adrenal glands
    C. parasympathetic nervous system and increased secretion from the thyroid gland
    D. parasympathetic nervous system and increased secretion from the pituitary gland

15. In response to low blood pressure the kidney produces Substance M, which in turn causes the adrenal cortex to produce Substance N. The presence of Substance N results in reabsorption of Substance Q and water into the blood. The reabsorption of water compensates for the low blood pressure. Substance Q is most likely

    A. ADH
    B. adrenaline
    C. aldosterone
    D. sodium ions

16. A person who drinks a large amount of water will have diluted blood. The body immediately reacts by

    A. increasing salt retention in the kidney
    B. decreasing salt retention in the kidney
    C. secreting antidiuretic hormone (vasopressin)
    D. inhibiting the secretion of antidiuretic hormone (vasopressin)

17. Kidneys play a major homeostatic role in regulating body fluids. Which would **not** be a reasonable inference?

    A. A person taking a ten-kilometre hike through very rough terrain would have a decrease in aldosterone secretion.
    B. A person consuming a high amount of salty bacon for breakfast would be thirsty.
    C. A carpenter working outdoors on a very hot day would probably have an increase in ADH secretion.
    D. Consuming an overabundance of fluid in a day would result in low ADH secretion and very watery urine.

18. From birth to age six, which endocrine glands promote growth?

    A. thyroid and testes
    B. pituitary and testes
    C. thyroid and adrenals
    D. pituitary and thyroid

19. A gland that has both endocrine and exocrine functions is

    A. pituitary
    B. pancreas
    C. thyroid
    D. adrenals

20. A drug which imitates the function of ADH could be used in treating the symptoms of

    A. high blood pressure
    B. hypothyroidism
    C. diabetes insipidus
    D. kidney stones

21. For each of the following statements, select the correct term from the two choices.

    a. Insulin will cause the blood sugar level to increase/decrease. **(1 mark)**

    b. A high/low PTH level could cause bone decalcification. **(1 mark)**

    c. When the blood sugar level is high/low, islet cells will release glucagon. **(1 mark)**

    d. Diabetes mellitus may result from dysfunction of the alpha/beta cells. **(1 mark)**

    e. One effect of adrenaline is the increase/decrease in blood flow to skeletal muscles. **(1 mark)**

    f. As a response to stress, the adrenal medulla/cortex secretes adrenaline. **(1 mark)**

    g. Releasing factors from the hypothalamus stimulate hormone production in the anterior/posterior pituitary. **(1 mark)**

22. Describe and illustrate a negative feedback system which involves the hypothalamus-pituitary complex and one other endocrine gland in the body. (**10 marks**; 8 marks for content and 2 marks for communication)

23. Describe how an increase in each of the following hormones would change blood glucose levels. Using complete sentences, explain how each hormone brings about such a change. **(6 marks)**

    a. thyroxin b. insulin c. adrenaline

24. a. Explain the role of ACTH and melanin when the skin is exposed to ultraviolet light. **(3 marks)**

    b. Discuss the relationship between exposure to ultraviolet light, ozone depletion, and skin cancer. **(2 marks)**

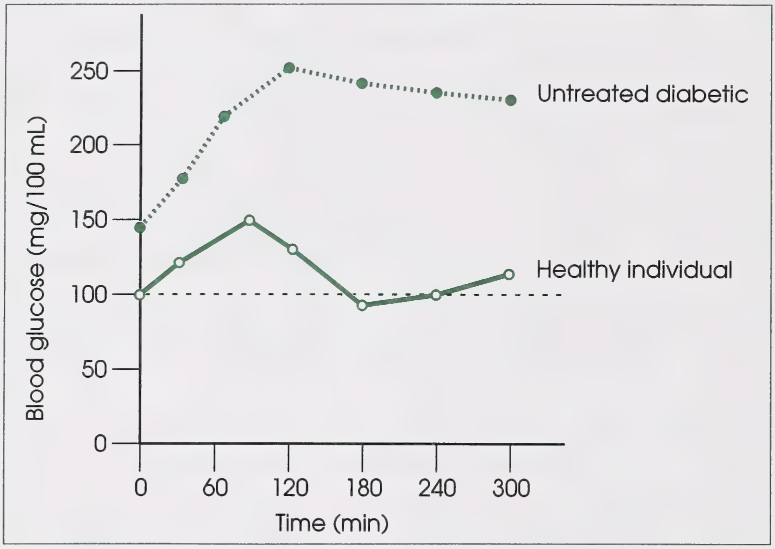
25. Describe the mechanism by which aldosterone helps maintain blood pressure. Begin your explanation as a response to low blood pressure. **(4 marks)**

26. Explain what hormonal biotechnology is and provide two ways it has benefited humans. **(3 marks)**

Use the following information to answer question 27.

Blood Sugar Regulation

At the beginning of an experiment, two individuals each swallowed 200 g of water containing 50 g of glucose. Their blood glucose levels were then tested at regular intervals. The individuals had similar body mass and basal metabolic rates. No activity was permitted.



Note: Homeostatic blood sugar level in healthy humans is about 100 mg/100 mL of blood.

27. Interpret and explain the response in blood glucose levels after reaching peak concentrations in each individual. **(5 marks)**

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☑ E. Synthesizing
- ☐ F. Evaluating

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐
Teacher:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐

SECTION 2

Reproductive Regulation

Do you remember what you looked like when you were 10 years old? How much have you changed? What caused the changes that your body has gone through? What role did the endocrine system play in your development?

You have seen from the previous section that the endocrine system is a very important system in your body. It plays a major role in maintaining a homeostatic state and in controlling changes. In this section you will continue to study the endocrine system but from a reproductive perspective. You will examine hormonal regulation of primary and secondary sex characteristics and you will develop an appreciation for the role hormones play in the menstrual cycle. You will learn how your health can be affected by prolonged use of reproductive hormones and by disruption of reproductive hormones during the aging process.

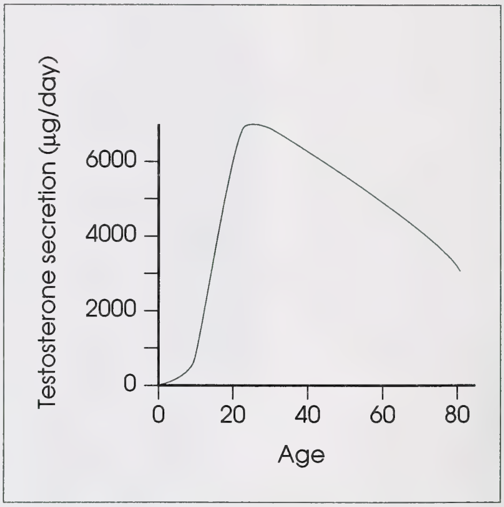
ACTIVITY

1 Male and Female Hormones

Estrogen, progesterone, testosterone – have you heard of these sex hormones before? Did you know that both sexes have these hormones? The difference is that each sex has different concentrations of them. The sex hormones in greater concentration will have a greater effect. In this activity you will investigate the effects of these hormones and how they control your sexual characteristics.

Male Hormonal Regulation

Male sex hormones are known as androgens. Testosterone is the most abundant and important androgen. The androgens are produced in the testes of the male. (Refer to the diagram of the endocrine glands found in Section 1, Activity 1 of this module to locate the testes.) To learn more about testosterone, read the passage Anabolic Steroids on page 172 in your text and study the graph on the right.



1. Describe testosterone secretion that occurs during a male's lifetime.

2. Identify some physical changes that occur in the male body during the time of significant increase in testosterone secretion (ages 10-20). These are mentioned briefly on page 183 in your text if you need a reference.

Check your answers by turning to the Appendix, Section 2: Activity 1.

Some of the characteristics that you described in question 2 were probably secondary sex characteristics. These are characteristics that are associated with a particular sex but are not components of the reproductive system. For example, increased hair growth in the facial region of the male is a secondary sex characteristic. In contrast to secondary sex characteristics are primary sex characteristics which are associated with the reproductive system. For males, they include the process of sperm formation and the development of the vas deferens and ejaculatory duct (see Figure 17.2, page 407 of your text).

As with many hormones, the production of testosterone is controlled by a second hormone. Study page 335 in your text and answer the next question.

3. What hormone regulates testosterone production and where is it produced?

To learn more about testosterone and its effects, read Hormonal Control of the Male Reproductive System from pages 410 to 411 of your text.

4. Where is testosterone produced?

5. Name the process by which sperm cells are produced.

6. List three secondary male sex characteristics that were not described in question 2.

7. What two structures control the secretion of testosterone?

8. Where are male gonadotropic hormones produced and what is their general function?

9. List two gonadotropic hormones and state the functions for each.

10. Do Review question 8 on page 411 of your text.

Another group of hormones which play a role in male regulation are the prostaglandins. To learn more about these hormones, read Prostaglandins on page 346 of your text.

11. Do Review question 18 on page 346.

Prostaglandins are believed to be secreted during the release of semen (ejaculation) into the female reproductive tract during sexual intercourse. The function of these hormones is to stimulate contractions in the female reproductive tract to assist movement of sperm cells to the egg.

Check your answers by turning to the Appendix, Section 2: Activity 1.

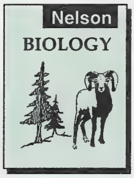
Much hormonal regulation in human males is affected by the age of the individual. However, in other species regulation may also be controlled by other factors. For example, the time of year will regulate sexual behaviour. Examples of environmental factors include photoperiod (amount of daylight) and temperature. There is a species of worm which lives in coral reefs of the South Pacific but mates at the ocean's surface. The unique reproductive feature of this species is that the entire population mates annually on one fall evening during a particular phase of the moon. People living in the area take advantage of this mating behaviour to catch the worms since they are regarded as a food delicacy.

Female Hormonal Regulation

The major female sex hormones are estrogen and progesterone. These hormones are produced in the ovaries of the female. Estrogen causes the development of primary and secondary sex characteristics in the female and is involved in the menstrual cycle, which you will learn about in the next activity.

12. Identify two secondary sex characteristics found in females.

Progesterone is a hormone that basically prepares the female for pregnancy. You will learn more about this hormone in the next activity.



The mechanisms controlling progesterone and estrogen are similar to those for the male hormones. To learn more about this, refer to Figure 17.9 on page 417 and answer the following questions. Notice the similarity between Figure 17.9 on page 417 and Figure 17.5 on page 411.

13. What hormone is released from the hypothalamus in both sexes?

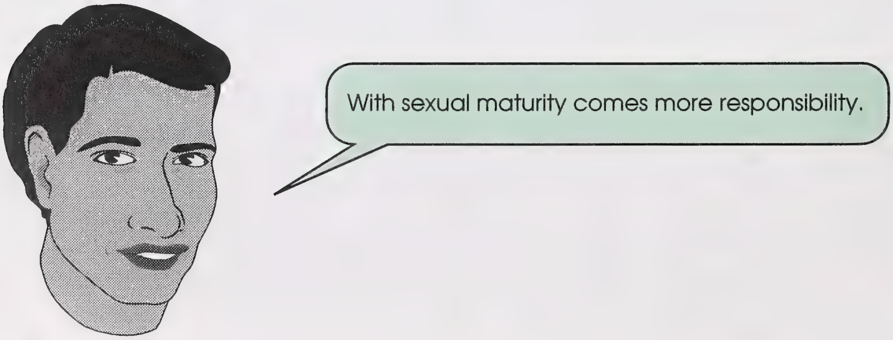
14. What hormones are released from the anterior pituitary in both sexes?

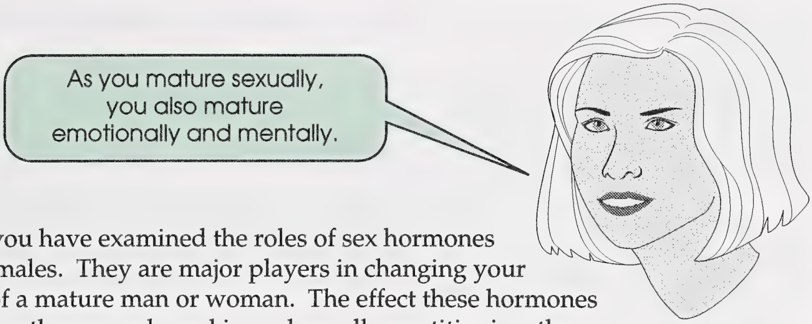
15. Describe the homeostatic mechanism which decreases secretion of estrogen and progesterone?

You will learn more about these mechanisms for controlling female hormones in Activity 2.

Check your answers by turning to the Appendix, Section 2: Activity 1.

Male and female hormonal regulation is somewhat controlled by age, but you should note that the beginning of puberty occurs at different ages for everyone and that there are a variety of secondary sex characteristics exhibited. Some people mature early and some later. One common factor is that the maturation process takes approximately seven years once it starts.


With sexual maturity comes more responsibility.


As you mature sexually, you also mature emotionally and mentally.

In this activity you have examined the roles of sex hormones in males and females. They are major players in changing your body into that of a mature man or woman. The effect these hormones have on you since they are released in such small quantities is rather amazing. In the next activity you will investigate the hormonal regulation of the menstrual cycle in females and the purpose it serves with regards to reproduction.

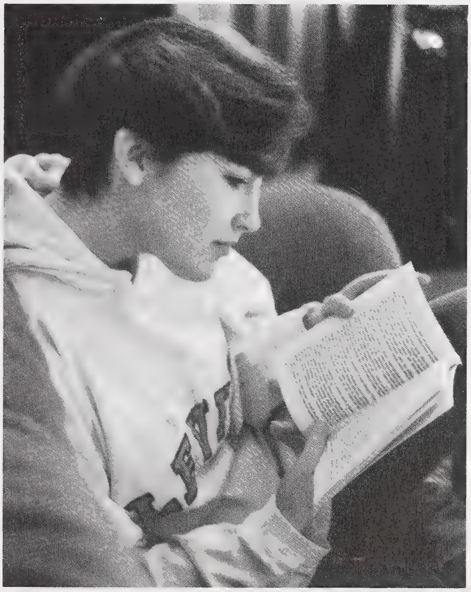
ACTIVITY

2 The Menstrual Cycle

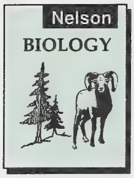
The menstrual cycle is one of those things which you have to experience to fully understand. This is one area where a male has no similar experience. The beginning of the menstrual cycle for a girl is a definite sign that she is growing up. It is an indication that she is reproductively capable of having a child of her own.

Before beginning a detailed discussion on the menstrual cycle, you should know that the menstrual cycle does not occur in all animal species. In fact only humans and other primates exhibit this type of cycle. Other species of mammals may exhibit what is called an oestrus cycle associated with seasonal reproductive behaviour. This cycle is also indicative of reproductive potential.

The menstrual cycle clearly illustrates the different hormonal pattern found in females compared to males. It is more complex and has a cyclical nature. The purpose of the cycle is to produce a mature ovum or egg every month which will create the potential for reproduction. A second purpose is to create an environment for growth of an embryo should fertilization occur. To get a better understanding of this cycle, you will have to know some terms.

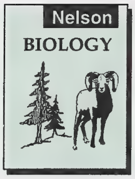


ADLC



1. Using pages 412 to 415 in your text, look up the following terms and compose a short definition.
   a. uterus
   b. endometrium
   c. menstruation
   d. follicle
   e. ovulation
   f. corpus luteum

Check your answers by turning to the Appendix, Section 2: Activity 2.



Now that you are familiar with some of the terminology, the next step is to look at the cycle itself. Read Menstrual Cycle on pages 415 and 416 of your text and answer the questions which follow.

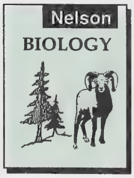
2. What is the average number of days for each menstrual cycle?
3. Identify and describe the four phases of the menstrual cycle.

The menstrual cycle is really two cycles. To clarify this statement, look at Figure 17.8 on page 416 of your text. The top third of the figure is known as the **ovarian** cycle; whereas the middle third of the figure refers to the **menstrual** cycle (also known as the uterine cycle).

4. Briefly explain what is happening in each of these cycles.
5. Where are estrogen and progesterone produced in the female?
6. What is the role of estrogen with respect to the endometrium?
7. Describe the effect of progesterone in the menstrual cycle.

Check your answers by turning to the Appendix, Section 2: Activity 2.

It often takes a couple of years from the onset of menstruation for a female to develop a regular cycle. Irregularity is a common occurrence in young women, and it's not unusual to skip a month or two or to have two periods in a single month.



How is the secretion of estrogen and progesterone controlled? You answered part of this question in Activity 1 of this section. To answer this question in greater detail, read Hormonal Control of the Female Reproductive System on pages 417 and 418 of your text.

8. What causes the release of GnRH?

9. Complete the following table by finishing the statements.

Ovarian Cycle (deals with the ovary)	**Menstrual (Uterine) Cycle (deals with the uterus)**
The release of FSH stimulates ...?	
Follicle secretes estrogen which causes ...?	The function of estrogen is to ...?
LH secretion causes the process of ...?	
Continued influence of LH causes the formation of ...?	
Corpus luteum causes the secretion of ...?	Buildup of estrogen and progesterone causes ...?
High estrogen and progesterone levels inhibit the release of ...?	
The inhibition of the gonadotropin hormones causes deterioration of ...?	
	Decreased estrogen and progesterone levels cause ...?

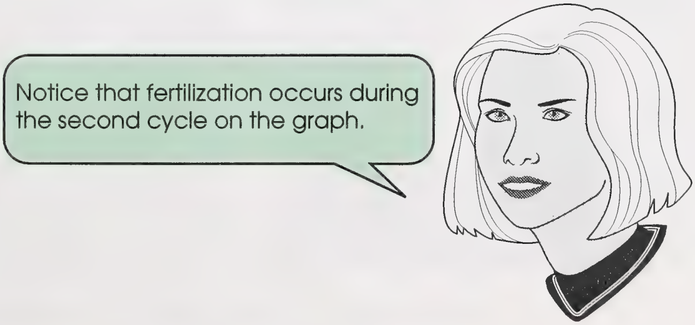
You can see that hormonal regulation in the menstrual cycle is more complex than in the male. To put all the pieces together, read the case study on Hormone Levels During the Menstrual Cycle on pages 419 and 420 of your text. Use what you have learned to answer the following questions.

10. Do Procedure questions a to k on pages 419 and 420 of your text. In question d, switch the terms *horizontal* and *vertical* when you draw the graph.

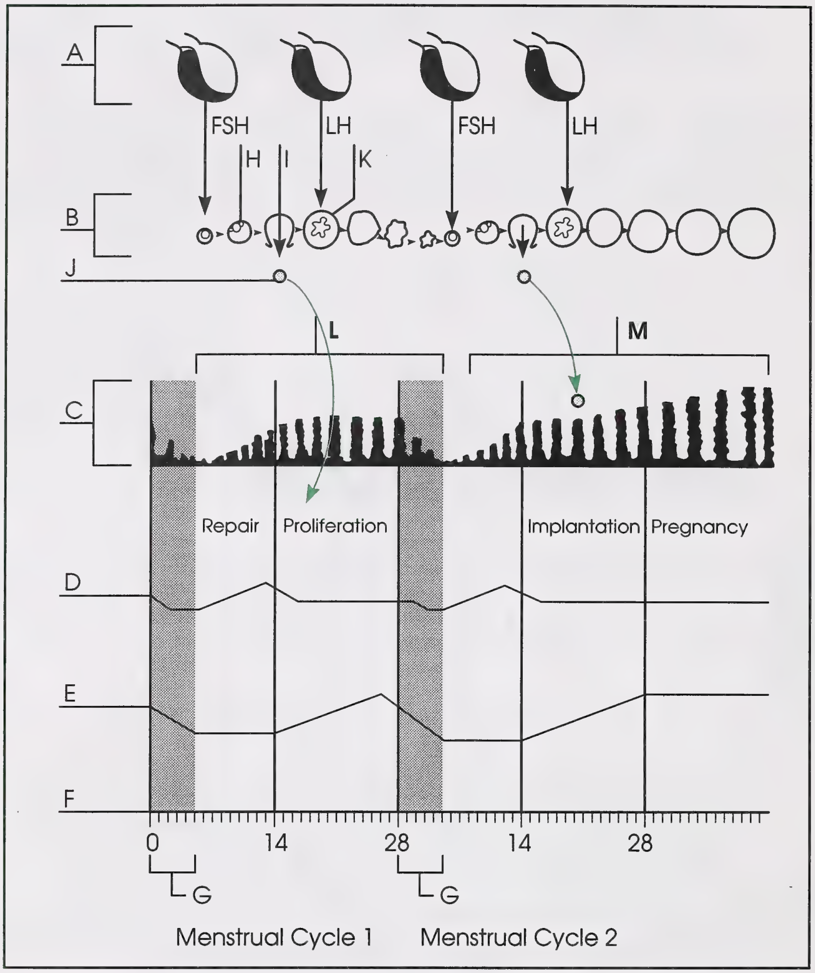
Check your answers by turning to the Appendix, Section 2: Activity 2.

By now you may have realized that there are two possible outcomes of the menstrual cycle. Fertilization may occur and result in pregnancy. Or, if fertilization doesn't occur, a menstrual period occurs and the cycle starts all over again.

Study the next diagrams showing these two possible occurrences. The diagram shows the events of the menstrual cycle with and without fertilization.


Notice that fertilization occurs during the second cycle on the graph.

Two Consecutive Menstrual Cycles Where Fertilization and Implantation Occur in the Second Cycle



A. Pituitary gland
B. Development of Graafian follicle and corpus luteum in ovary
C. Wall of uterus
D. Estrogen level
E. Progesterone level
F. Time in days

G. Menstruation
H. Graafian follicle
I. Ovulation
J. Ovum
K. Corpus luteum
L. Ovulation without fertilization
M. Ovulation with fertilization

11. What occurs in both cycles on Day 14?

12. Describe the condition of the endometrium on Day 28 in both cases.

13. Compare the behaviour of the endometrium in the two cases.

14. Describe the behaviour of the corpus luteum in the two cases.

15. Compare the level of progesterone in the two cases.

16. What event does not occur on Day 28 thus indicating that fertilization and implantation occurred?

Check your answers by turning to the Appendix, Section 2: Activity 2.

In this activity you have examined hormonal regulation of the menstrual cycle in human females. The gonadotropic hormones and the ovarian hormones interact with each other to control the events in this cycle. The cycle allows the human species to continue to exist through reproduction. This cycle is another example illustrating the intricate working of the endocrine system to maintain a homeostatic balance in the body.

ACTIVITY

3 Hormones and Health

In the previous activities you have seen the vital role hormones play in maintaining homeostasis in your body. The last activity in this module will explore the changes in the homeostatic state. Menopause, birth control pills, and anabolic steroids will be discussed.

Menopause

Women continue to have a menstrual cycle up until the ages of forty-five to fifty. At this age the menstrual cycle becomes irregular and eventually ceases. The reason for this is that there are only a few follicles remaining in the ovary which can be stimulated to mature. All the other follicles have degenerated. This period, during which the menstrual cycle becomes irregular and eventually ceases, is known as menopause.

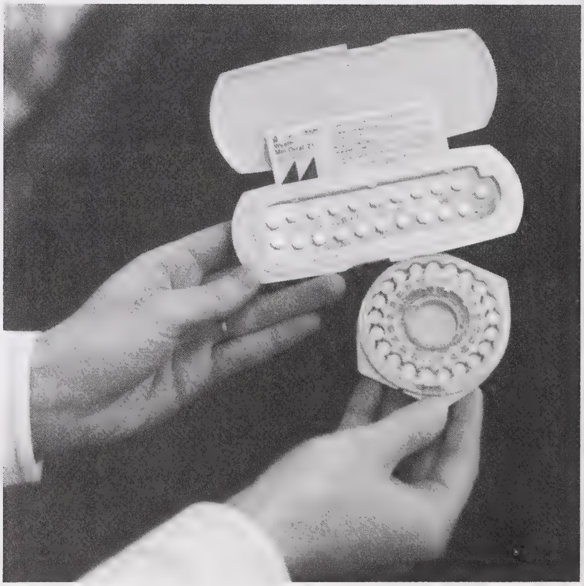
Use information on pages 415 to 418 to answer the next questions.

1. What hormone is most affected by failure of follicles to develop? What are some possible consequences of loss of secretion of this hormone?
2. What other hormone is not produced if there is no menstrual cycle? What is a consequence of not having this hormone?
3. Once the menstrual cycle has stopped, is reproduction possible? Explain.

Check your answers by turning to the Appendix, Section 2: Activity 3.

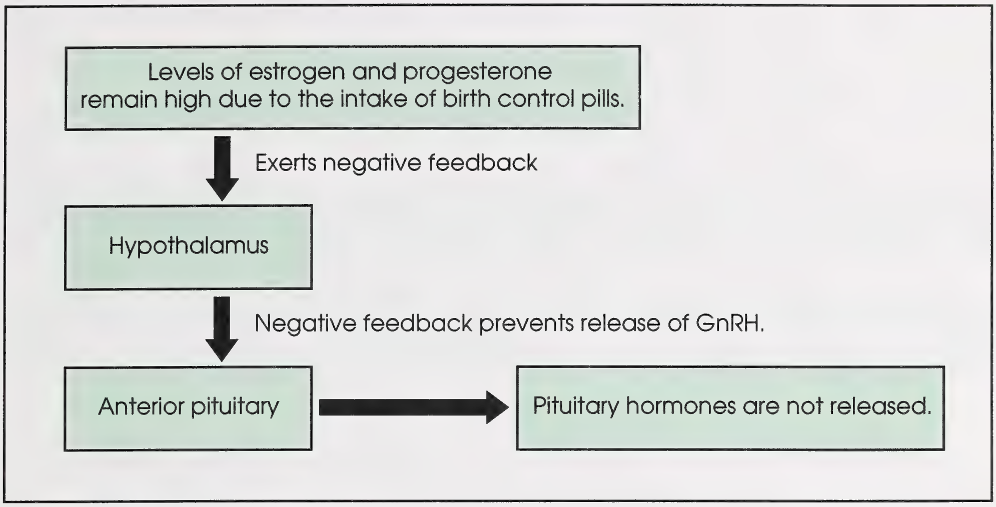
With the loss of hormones, especially estrogen during menopause, a woman's body can be dramatically affected. Women may experience "hot flashes" with flushing of the skin, sensations of difficulty in breathing, irritability, anxiety, and fatigue. This is just another example to reinforce the significance of hormones in the body. Over time, women eventually adjust to the loss of estrogen and return to a normal healthy life which is back in a homeostatic state. The lack of the ability of a woman to reproduce doesn't necessarily mean any change in her usual sexual activity.

Birth Control Pills



Other than abstinence, one of the most efficient ways of preventing pregnancy is the use of oral contraceptives (pills taken orally). The "pill" if taken correctly has less than a 1% failure rate. The composition of the pill is mainly synthetic estrogen and a synthetic progesterone-like substance. For a 28-day cycle, a pill is taken daily for the first 21 days, and then stopped for the last seven days.

Through negative feedback the hormones in the pill prevent the release of GnRH.


Levels of estrogen and progesterone remain high due to the intake of birth control pills.
Exerts negative feedback
Hypothalamus
Negative feedback prevents release of GnRH.
Anterior pituitary
Pituitary hormones are not released.

4. What hormones are not released if GnRH is not released? Describe the consequences of not releasing these hormones.

5. What two events do not occur in the ovary because of the action of the pill?

While the woman is taking oral contraceptives, the production and the maintenance of the lining of the uterus occurs as normal.

6. Why does the production and maintenance of the lining occur as normal while the woman is on the pill?

7. What happens to the hormone levels of estrogen and progesterone after the twenty-first day of the menstrual cycle once the woman stops taking the pill? How does this affect the endometrium?

8. Which cycle is most affected by oral contraceptives, menstrual or ovarian? Explain your answer.

Check your answers by turning to the Appendix, Section 2: Activity 3.

On Day 29 the woman resumes taking the oral contraceptive pills for the next cycle. What the birth control pill does, in a simplistic sense, is that it fools the body into thinking that it is in a state of pregnancy.

A long-lasting contraceptive device in the form of a small implant has been invented. This implant, which releases hormones, is placed under the skin and is functional for up to five years. The device is not yet commonly available.

So what about side effects? Can taking oral contraceptives be dangerous? Research has been done to study the long-term effects of progesterone/estrogen treatment. Possible long-term effects can include a suppression of ovulation after use of the pill is discontinued and cardiovascular problems such as blood clotting, atherosclerosis, and heart attack. Smoking along with taking oral contraceptives substantially increases the risk of health hazards. The other side of this is that women taking oral contraceptives do not risk the dangers of pregnancy. Yes, pregnancy can be dangerous. In a small number of cases complications may occur in a pregnancy that may threaten the life of the mother or fetus or both. Complications may include toxemia, postpartum hemorrhage, increased blood pressure, varicose veins, and others. Medical technology reduces the risks and hazards of these complications, but they remain associated with a small number of pregnancies none the less.

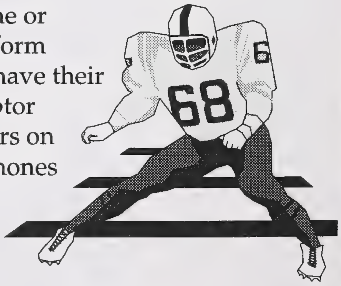
9. What are the possible long-term effects of taking birth control pills?

10. If the long-term effects are valid, do you think women should take birth control pills? Explain your answer.

Check your answers by turning to the Appendix, Section 2: Activity 3.

The only method that is 100% effective in preventing pregnancy is abstinence (not having sexual intercourse at all). Your parents, physician, or school nurse can give you more information about birth control.

Anabolic Steroids



Anabolic steroids are hormones produced from testosterone or testosterone-like compounds. The term *anabolic* means to form complex structures from simpler ones. Steroid hormones have their effect by diffusing into the cell cytoplasm to attach to receptor molecules. In contrast, protein hormones attach to receptors on the cell membrane. Specifically, anabolic steroids are hormones which create muscle mass by increasing production of protein in the body. In recent years, athletes have taken these drugs to enhance their performance.

Performance may be enhanced because these steroids build muscle, however, long-term use of these hormones creates dangers for those who take them. In teenagers, taking steroids may actually inhibit growth because it prevents the expansion of bone parts. In men, it causes breast development and leads to shrinkage of testes and possible impotence. In women, it results in decreased breast size, deeper voice, and increased facial and body hair. In all individuals, it increases the risk of atherosclerosis and heart disease. Anabolic steroid use is also linked to certain cancers and decreased immunity. Is steroid use worth the risks?

Nelson
BIOLOGY

Read the description of anabolic steroids on page 172 and the Social Issue on page 173 in your text.

11. Create a table like the following one to summarize the long-term effects of anabolic steroids.

Science Skills

☐ A. Initiating
☐ B. Collecting
☑ C. Organizing
☐ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

Effects in Teenagers	Effects in Women	Effects in Men	Effects in All Individuals

Check your answers by turning to the Appendix, Section 2: Activity 3.

In this activity you have studied the effects of the naturally occurring process of menopause and you have looked at the effects of upsetting the homeostatic state in the body. You examined the long-term effects of oral contraceptives and anabolic steroids. The findings in the last two activities should remind you that the body is an independent living structure and that when the workings of that structure are interfered with, there may be negative consequences. It is important to be aware of these consequences and make the correct decision.

Follow-up Activities

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Do the following questions to review important concepts from Section 2.

1. For the following series of statements, unscramble the underlined word.

The three major sex hormones are a. rgneoset, b. eoesgrpoetrn, and c. noeretostset. The sex hormone found in higher concentrations in males than females is d. eoestetsotrn, whereas the female sex hormones found in higher concentrations include e. enoretsegorp and f. negortse.

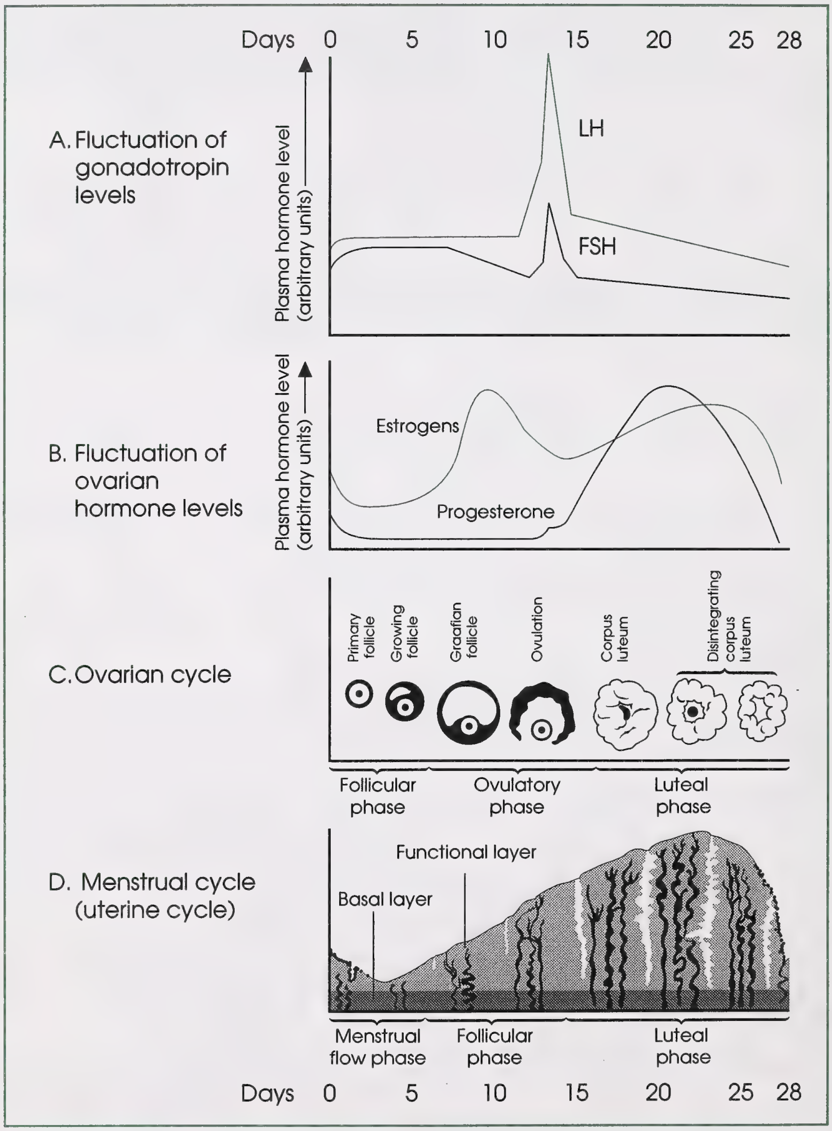
Testosterone is produced in the male g. esestt, specifically in the h. tttiiinersal i. elslc. Estrogens and progesterone are produced in the female j. osveair.

Testosterone has its greatest increase during the stage of growth known as k. berytup and it peaks at around age l. ynwtet. Testosterone functions in developing m. yrampri and n. eodrscnay sex characteristics.

The counterpart to testosterone in the male is o. negortse in the female, which is responsible for the development of primary and secondary p. exs characteristics. Progesterone prepares the female for q. nangerpyc.

The r. ahtmalsuophy, anterior s. ptiayiutr, and t. tsstei provide negative feedback regulation of the maturation of male sex characteristics. This control mechanism is also found in females except instead of the testis, the u. ravoy is involved.

2. Refer to the following series of diagrams to answer the next group of questions.



With the onset of puberty, there is the release of GnRH from the hypothalamus. The release of GnRH stimulates the anterior pituitary to secrete FSH and LH.

a. Looking at the ovarian cycle and gonadotropin levels, what does the initial release of FSH cause to happen in the ovarian cycle?

The developed follicle now begins secreting estrogen.

b. Looking at the ovarian hormone levels and the menstrual cycle, what happens in the menstrual cycle when estrogen levels go up?

c. Which peaks first – estrogen or the gonadotropic hormones?

The steep increase in estrogen causes greater secretion of FSH and LH.

d. What event occurs just after the peaking of the gonadotropic hormones?

After ovulation, LH stimulates the remains of the follicle to form the corpus luteum.

e. As the corpus luteum is forming, what is happening to the progesterone levels? What happens to the progesterone levels as the corpus luteum is disintegrating?

f. As estrogen and progesterone are kept at fairly high levels during the secretory phase of the menstrual cycle, what is the condition of the endometrium?

g. What happens to the endometrium when estrogen and progesterone levels drop around Day 25?

3. For each of the following statements, determine to which of the terms it is related.

(A) Anabolic steroids (B) Birth control pills (M) Menopause

Place the letter (A, B, or M) of your choice in the space provided. Only one letter may be used for each statement.

a. ______ These are composed of testosterone or testosterone-like substances.

b. ______ This occurs between forty to fifty years of age.

c. ______ Cardiovascular problems are possible.

d. ______ Flushing of the skin may occur.

e. ______ This builds muscle mass.

f. ______ Few follicles are left in the ovary.

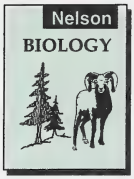
g. ______ This is composed of estrogen and progesterone-like substances.

h. ______ The menstrual cycle ceases.

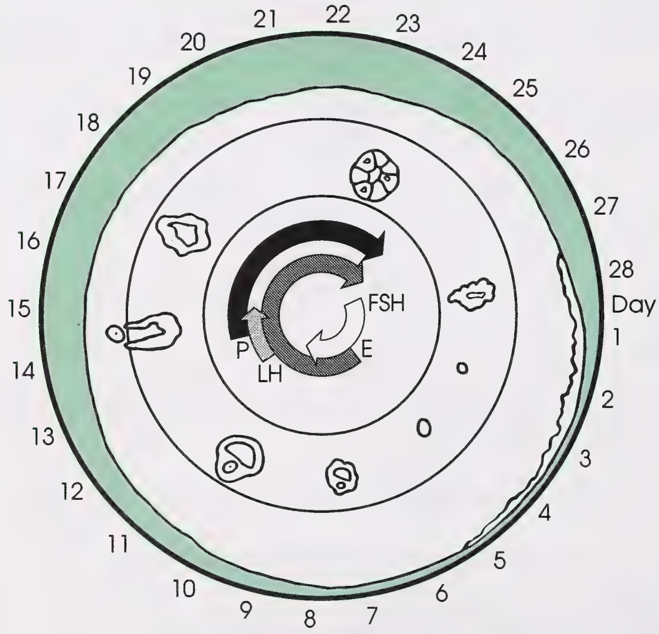
Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Do one of the following activities.



1. Do Critical-Thinking question 2 on page 429 in your text.
2. If you are a female, chart your period for a couple of months on a calendar so that the length and frequency of your period can be determined. Use this diagram to correlate your cycle to the events you've studied.



The innermost circle shows secretion of hormones by pituitary gland and ovarian follicle.

FSH = follicle-stimulating hormone
E = estrogen
LH = luteinizing-hormone
P = progesterone

The middle circle shows ripening of ovarian follicle from day 1 to ovulation on day 14 and subsequent formation of corpus luteum.

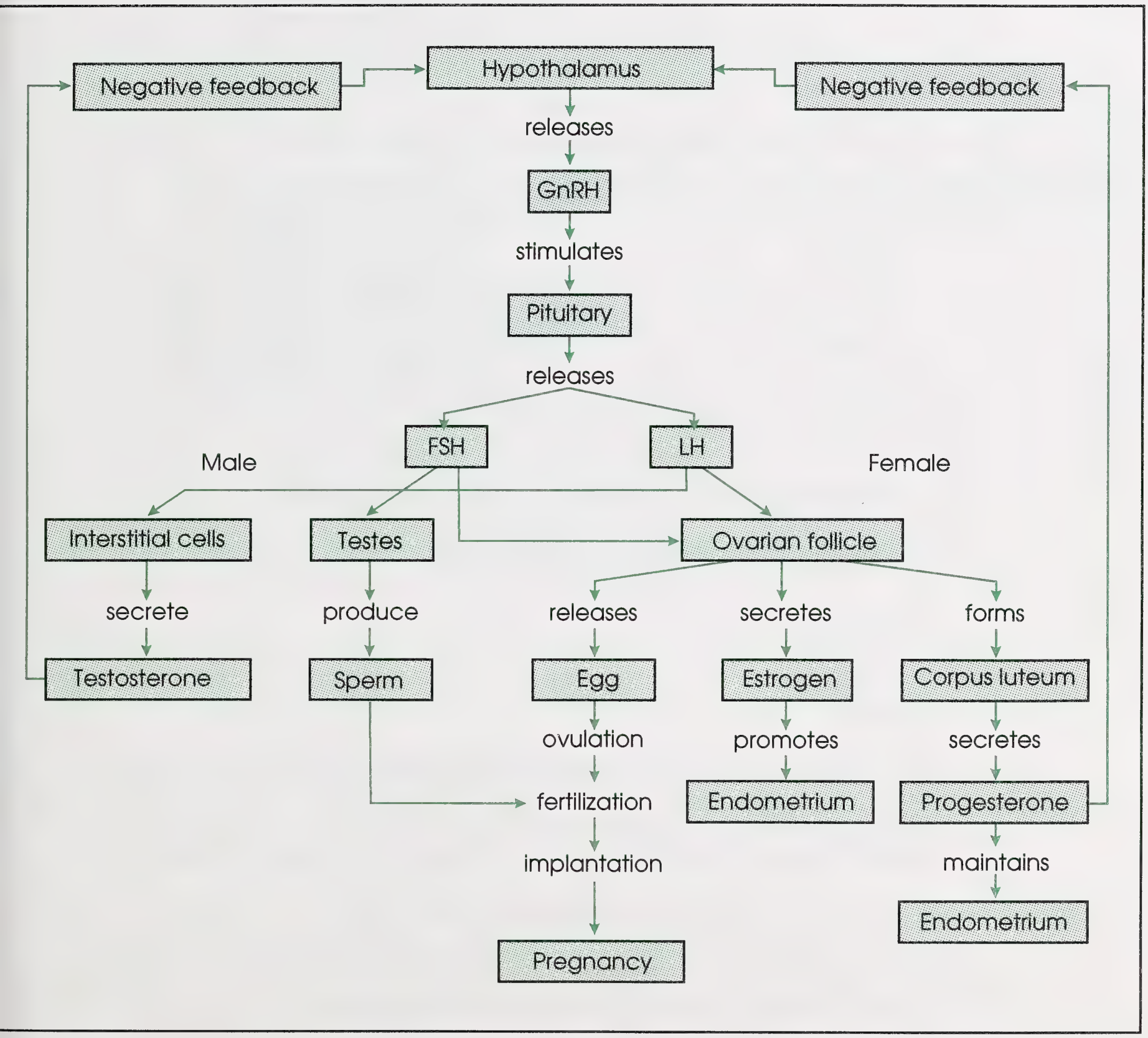
The outer circle shows build up of uterine lining and menstruation from day 28 to day 5.

3. Make a scrapbook of newspaper articles dealing with anabolic steroids.

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

In this section you have examined the role of sex hormones in developing primary and secondary sex characteristics. You have studied the relationships between gonadotropic hormones and ovarian hormones in the menstrual cycle. You have explored the effects of hormones when the homeostatic state is lost due to menopause, oral contraceptives, and anabolic steroids. Hopefully you have been able to gain an understanding and appreciation of the role hormones play in reproduction. The following diagram summarizes the major reproductive hormones and their affects. You should be able to recognize all the terms.



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Section 2 Assignment: Reproductive Regulation

Response Page Setup

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

Biology 30 – Module 2   Section 2 Assignment   Page #   Name and ID#

Be sure to write legibly. Leave a wide left margin and number all of your pages.

Carefully read each of the following multiple choice questions and decide which of the choices **best** completes the statement or answers the question. Each question is worth 1 mark.

1. The testes are considered endocrine glands because of their production of

   A. androgens
   B. sperm
   C. FSH
   D. LH

2. The follicle secretes

   A. androgen
   B. estrogen
   C. LH
   D. progesterone

3. The endometrium is the lining of the

   A. bladder
   B. vagina
   C. kidney
   D. uterus

4. In a laboratory experiment, the pituitary gland was removed from a number of immature female mice; the ovaries of these animals did not develop normally. The pituitary gland was also removed from some mature female mice and their ovaries and uterus stopped functioning. What do these observations best indicate?

   A. The ovaries and uterus influence the pituitary gland.
   B. The pituitary gland influences the ovaries, which in turn influence the uterus.
   C. The pituitary gland influences the ovaries and uterus.
   D. There is feedback between the ovaries and the pituitary.

5. An adult male who lacks facial hair, has a high-pitched voice, and has an increased subcutaneous layer of fat likely suffers from insufficient secretion of

   A. insulin
   B. thyroxin
   C. testosterone
   D. growth hormone

6. Testosterone is sometimes used in treating cancer of the vagina. A side effect of this treatment would be that the patient may

   A. produce and secrete male sex hormones
   B. develop male primary sex characteristics
   C. develop male secondary sex characteristics
   D. acquire both male primary and male secondary sex characteristics

Use the following information to answer the next two questions.

	Subject W	Subject X	Subject Y	Subject Z
Progesterone	+++	– –	++	+
Luteinizing hormone (LH)	++	+++	– –	+
Follicle-stimulating hormone (FSH)	– –	++	+	+++
Estrogen	++	+++	++	+

Note: "+" denotes relative concentration of hormone
"–" denotes trace amount of hormone present

7. In which subject is a new egg starting to develop in the follicle?

   A. W
   B. X
   C. Y
   D. Z

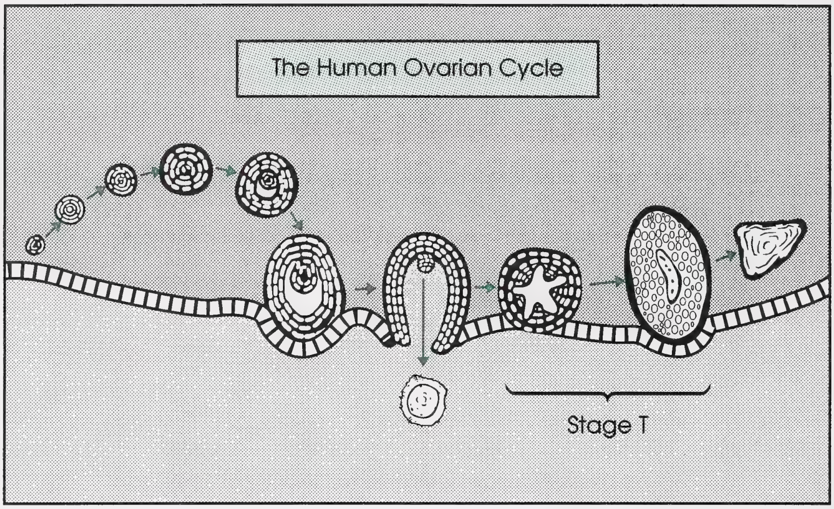
8. Which subject is about to begin menstruation?

   A. W
   B. X
   C. Y
   D. Z

9. Damage to a female's pituitary gland just before puberty may result in

   A. a reduction in estrogen production and inhibition of the development of secondary sex characteristics
   B. a reduction in estrogen production and stimulation of the development of secondary sex characteristics
   C. an increase in progesterone production and inhibition of the development of secondary sex characteristics
   D. an increase in progesterone production and stimulation of the development of secondary sex characteristics

Use the following diagram to answer question 10.



10. Stage T represents which phase of the ovarian cycle?

    A. ovulation
    B. implantation
    C. follicle development
    D. corpus luteum development

11. What is the immediate effect of a high level of luteinizing hormone (LH) on the ovary?

    A. prevents ovulation
    B. delays menstruation
    C. stimulates ovulation
    D. stimulates menstruation

12. A pituitary disorder that inhibits FSH production would

    A. induce ovulation
    B. induce menstruation
    C. prevent development of a new follicle
    D. stimulate the development of a new follicle

13. Gonadotropic hormones include

    A. testosterone and estrogen
    B. FSH and LH
    C. testosterone and LH
    D. progesterone and estrogen

14. During the stage of menopause, females secrete little or no

    A. FSH
    B. LH
    C. estrogen
    D. LH and estrogen

15. Anabolic steroids can affect the body by

    A. decreasing body hair
    B. decreasing muscle development
    C. decreasing bone growth
    D. decreasing energy levels

16. Discuss the chemical composition of oral contraceptives and explain how birth control pills prevent pregnancy. **(4 marks)**

17. To treat a form of degenerative bone disease known as osteoporosis, testosterone is sometimes given to elderly male individuals. Examine the graph on testosterone secretion at the beginning of this section and explain why this treatment may be necessary and helpful. **(3 marks)**

Science Skills

☐ A. Initiating
☐ B. Collecting
☑ C. Organizing
☐ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

18. The following list of statements represents a random order of events during the menstrual cycle. Put the statements in the proper order by placing the correct letter (a-e) next to the statement. **(5 marks)**

_______ Ovulation occurs.

_______ The corpus luteum releases estrogen and progesterone.

_______ The pituitary releases FSH and LH.

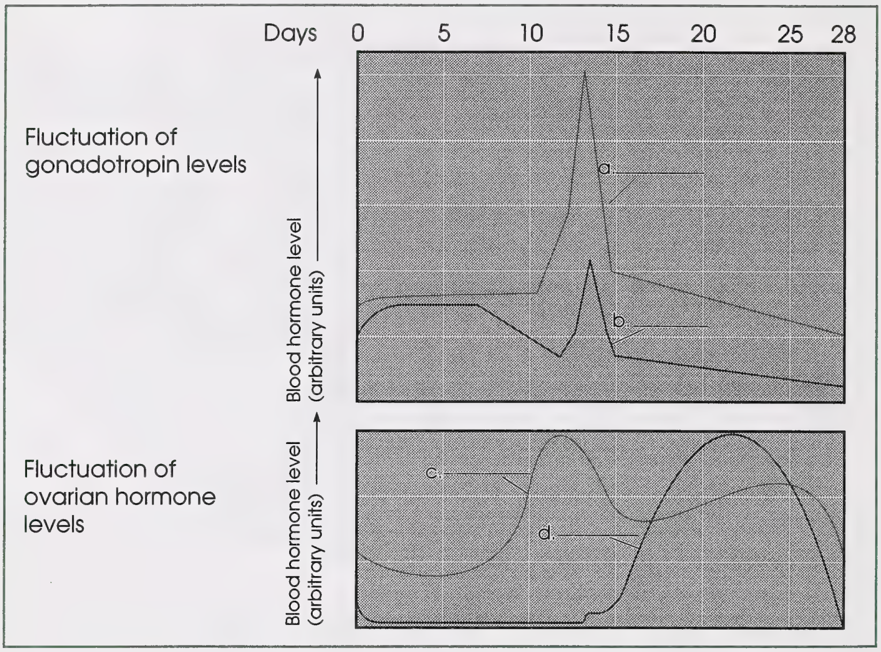
_______ Estrogen and progesterone inhibit production of FSH and LH.

_______ The follicle secretes estrogen.

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐
Teacher:	A. ☐	B. ☐	C. ☐	D. ☐	E. ☐	F. ☐

Use the following diagram to answer question 19.



19. Using the following diagram, identify the hormones (a, b, c, d) that are associated with each graph and briefly describe their effect on the female reproductive cycle. **(4 marks)**

20. Answer the following questions concerning the menstrual cycle.

    a. Describe the function of GnRH? **(2 marks)**

    b. What role does FSH play in this cycle? **(1 mark)**

    c. What causes the peak in LH? **(1 mark)**

    d. What does the peak in LH cause? **(1 mark)**

e. During the luteal phase, what role does LH have? **(1 mark)**

f. What inhibits secretion of LH and FSH? **(1 mark)**

g. What allows FSH and LH levels to increase again? **(2 marks)**

MODULE SUMMARY

In the previous module you learned about the nervous system and its role in communication throughout the body. In this module the focus was on another communication system – your endocrine system. You were able to examine how these two important systems worked together. You studied the major glands of the endocrine system along with the hormones they release and their metabolic roles. You learned about the role hormones play in reproduction. You explored situations where humans, through technological advances, have manipulated the endocrine system. In working through this module you should have gained an appreciation for the endocrine system and its vital role in keeping your body in a homeostatic state.

To ensure that all of your work has been completed in a satisfactory manner, check off the items in the following list:

☐ Section 1 Assignment has been completed.
☐ Section 2 Assignment has been completed.
☐ Your responses are organized and neat, with room for teacher comments.
☐ All your response pages are numbered consecutively and identified with this heading.

Biology 30 – Module 2 Section # Assignment Page # Name and ID #

Appendix

Glossary

Suggested Answers

Glossary

intravenous: a medical procedure where a fluid is allowed to drain directly into a vein

stress: a condition which results when an individual is exposed to an external stimulus (psychological or physical) which disrupts the internal environment in the body

Suggested Answers

Section 1: Activity 1

1. A hormone is a chemical regulator (messenger) produced by cells in one part of the body that will influence the activity of cells in another part of the body. Hormones are required in small amounts.

   Target tissues contain cells that have receptor sites that bind specific hormones.

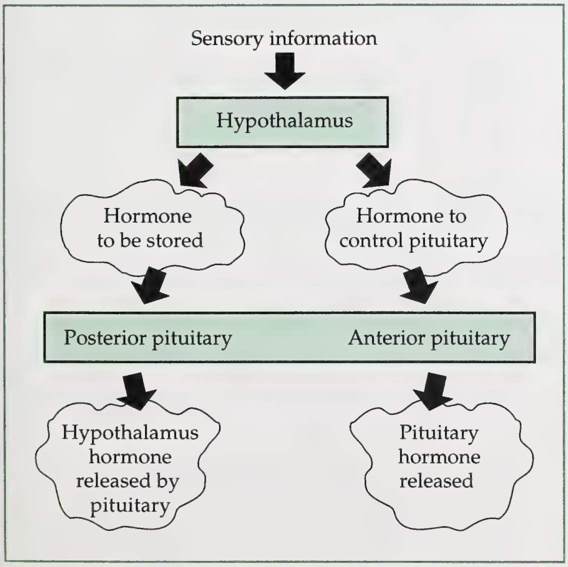
2.

	Nervous System	Endocrine System
Mode of transmission	electrochemical through neurons	chemical through blood
Duration of effect	usually shorter	usually longer
Reaction time	faster	slower

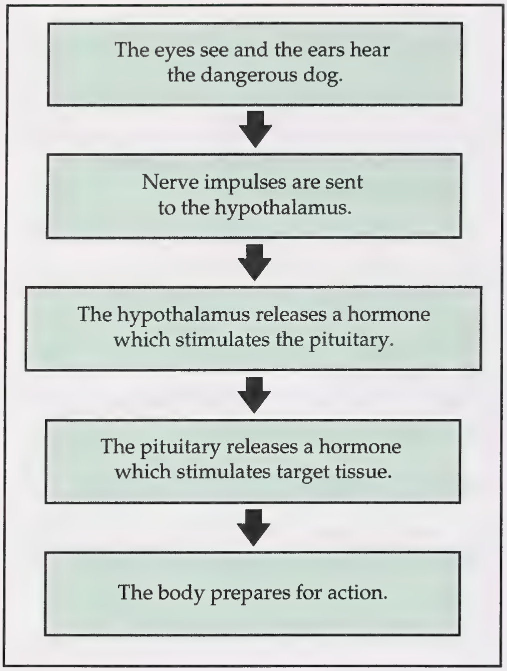
3. a. hypothalamus
   b. pituitary
   c. thyroid
   d. parathyroids
   e. adrenals
   f. pancreas
   g. ovary
   h. testis

4. The kidneys are just below the adrenal glands.

5.


Sensory information
Hypothalamus
Hormone to be stored
Hormone to control pituitary
Posterior pituitary
Anterior pituitary
Hypothalamus hormone released by pituitary
Pituitary hormone released

6.



The eyes see and the ears hear the dangerous dog.

Nerve impulses are sent to the hypothalamus.

The hypothalamus releases a hormone which stimulates the pituitary.

The pituitary releases a hormone which stimulates target tissue.

The body prepares for action.

Section 1: Activity 2

1.

Endocrine Gland	Hormone	Target Cells	Primary Function
posterior pituitary	antidiuretic hormone (ADH) (vasopressin)	kidney	increases water reabsorption
anterior pituitary	growth hormone (GH)	most cells	promotes growth (particularly skeletal; affects metabolic functions)
	thyroid-stimulating hormone (TSH)	thyroid gland	stimulates release of thyroxin
	adrenocorticotropin hormone (ACTH)	adrenal cortex	stimulates release of hormones involved in stress responses
parathyroid	parathyroid hormone (PTH)	bone cells	regulates calcium levels in the body (stimulates calcium release from bone)
pancreas	insulin	most cells	increases permeability of glucose in cells
	glucagon	liver cells	promotes conversion of glycogen to glucose
adrenal medulla	adrenaline (or epinephrine)	most cells	prepares body for stress situation (increases blood sugar; increases heart activity; constricts blood vessels in skin and kidneys)
	noradrenaline (or norepinephrine)	most cells	prepares body for stress situation (basically the same effects as adrenaline)

Endocrine Gland	Hormone	Target Cells	Primary Function
adrenal cortex	cortisol	most cells	increases the level of amino acids in the blood (increases blood sugar by affecting carbohydrate metabolism)
	aldosterone	kidney	increase sodium retention and water reabsorption
thyroid	thyroxine	most cells	regulates metabolic activity

2. Digestion decreases, heart rate increases, breathing quickens, and blood pressure goes up in response to stress.

3. The reactions to stress are called the fight-or-flight response.

4. The autonomic nervous system controls the endocrine glands.

5. The hormones released from the adrenal gland are adrenaline and corticoids.

6. When adrenaline is released, the heart beats stronger and faster; the breathing rate increases; stomach activity decreases; the liver makes more sugar available; the pupils dilate; and the peripheral (skin) capillaries constrict thus shunting blood away from the skin and towards the brain, lungs, and skeletal muscles.

7. Adrenaline is known as the fight-or-flight hormone.

8.

Nervous Component	Function or Effect
Sensory receptors generate nerve impulses that travel to the hypothalamus.	• causes the hypothalamus to initiate stimulation of the sympathetic nervous system and adrenal glands
Sympathetic impulses go to various organs and tissues.	• increases blood glucose concentration, blood glycerol concentration, blood fatty acid concentration, heart rate, blood pressure, and breathing rate • dilates air passages • shunts blood to skeletal muscles • increases secretion of epinephrine from adrenal medulla
Hormonal Component	
Adrenaline is secreted by the adrenal glands and enters the blood stream.	• same effects as sympathetic nervous system

9. General adaptation syndrome involves a set of reactions which allows the body to respond to stress in an attempt to restore homeostasis. First the body responds to stress; then when the stress factor decreases, the body returns to normal.

10.
- **Textbook question 7**: Decreased secretions of growth hormone prior to puberty may cause dwarfism.
- **Textbook question 8**: Increased secretions of growth hormone cause the long bones and facial bones to widen. Often the bones will become more brittle.

11. **Review question 15**: Hypothyroidism, or insufficient thyroid activity, causes lower metabolic rates, a tendency to gain weight, and lower levels of energy expenditure. People who have hypothyroidism tend to easily get cold and quickly fatigue. Hyperthyroidism, or too much thyroid activity, increases metabolic rate, causing a tendency to reduce body fat and increase levels of energy expenditure. People who have hyperthyroidism tend to fatigue less easily and remain warm even on cold days.

12. **Review question 17**: An enlargement of the thyroid gland is called a goiter.

13. In a stress condition, the hypothalamus produces a releasing hormone that causes the anterior pituitary to release ACTH. ACTH causes the adrenal cortex to release cortisol, which goes to the liver and muscle cells. Cortisol also goes to the hypothalamus and pituitary and suppresses both their secretions. In this way the actions that originally increased cortisol secretion are stopped and cortisol levels drop.

Section 1: Activity 3

1. c, f, i, a, h, e, g, b, d, j

2. Sample observations

Substance Used	Observations
card, opaque tape, or lightproof envelope	large amount of yeast growth
no substance used/totally exposed	no yeast growth observed
sunscreen SPF 4	very little growth
sunscreen lotion SPF 8	medium amount of growth (more than with sunscreen of SPF 4)
sunscreen lotion SPF 15	large amount of yeast growth but not as much as in the culture covered by a card or opaque tape

3. The manipulated variable is the type of material being used to absorb ultraviolet light. The responding variable is the amount of yeast growth in each exposed area.

4. There were actually two controls used in this experiment. One control was the area of the petri dish which was covered by the card, opaque paper, or lightproof envelope. The other control was the half of the petri dish which was not covered by anything and was totally exposed to the sunlight. Both of these controls were used as comparisons to the rest of the data.

5. The controlled variables in this experiment include the use of the same type of yeast, the samples being exposed at the same time of day for the same period of time, the samples being stored at the same temperature, the samples being stored in the dark, and the yeast being supported by the same type of agar.

   Remember the control or control group in an experiment is not the same as the controlled variables. The control is used as a comparison; whereas controlled variables are variables held constant in an experiment.

6. The presence of ultraviolet light could be detected by the amount of yeast growth in the sample areas. Ultraviolet light reduces the amount of yeast growth.

7. The effect of the different materials was determined by the amount of yeast growth. The more ultraviolet light that a sample was exposed to, the less growth there would be.

8. Answers will vary. The material which blocked out the most UV light, besides the control, could be the sunscreen with the highest SPF or the lens which absorbs UV light the best. You could tell which blocked out the most UV light by examining the amount of growth. The one with the most growth blocked out the most ultraviolet light.

9. With depletion of the ozone layer, more ultraviolet light can penetrate to the Earth's surface.

10. $60\% \times 4 = 240\%$ The predicted percentage of increase in skin cancer would be 240%. (Did you read the Biology Clip on page 24?)

11. Fair-skinned people don't have enough skin pigment to absorb sunlight.

12. The sunscreen must have at least an SPF factor of 15. An SPF factor lower than 15 may not be effective.

13. Both UV-A and UV-B rays will be blocked by SPF sunscreens.

14. Suntanning machines emit the same wavelengths as the sun.

15. Other protective measures besides wearing sunscreens are wearing a wide-brim hat, long pants, and long-sleeved shirts. Of course, the best protective measure is to avoid being out in the sun.

16. Possible signs of early skin cancer include change in a skin growth, appearance of a new skin growth, or open sores that do not heal.

17. Sunlight can reflect from snow thus increasing the chance of sunburn.

18. Sunscreens allow for increased absorption of ultraviolet light. With greater absorption, the UV light is prevented from penetrating the skin and damaging the melanocyte cells or other actively dividing cells. It allows you to stay out in the sun for a longer period of time without burning. This is because the melanocyte cells are buffered by the sunscreen and therefore do not have to release melanin as quickly.

19. Increasing the amount of exposure to ultraviolet light increases the rate of pigment deposition within the skin cells. This in turn increases the amount of time your skin can be exposed to ultraviolet light before being burned.

Section 1: Activity 4

1. The islets of Langerhans contain the endocrine cells in the pancreas.

2. The pancreas produces insulin and glucagon as endocrine secretions.

3. a. Insulin is normally secreted after a large meal to facilitate the absorption of glucose by cells.

   b. Glucagon would be secreted in the morning to cause an increase in blood sugar from conversion of glycogen in the liver to provide energy. Insulin would also have to be present to assist glucose entering your cells.

4. Removal of the pancreas caused a lack of insulin in the blood. Without insulin, blood glucose increased to a point where it began to be excreted by the kidneys and was noted in the urine.

5. Initially digestive enzymes destroyed the hormone in the pancreas.

6. The presence of glucose in the urine may indicate that glucose is not being utilized by body cells. Without glucose for respiration, body cells will have a shortage of energy.

7. The function of the excretory system is to maintain proper levels of substances circulating through the blood.

8. The composition of urine relates to the waste products and substances in excess in the blood.

9. a. Glucose is a monosaccharide and all monosaccharides are reducing sugars. A reducing sugar will react with Benedict's solution to produce a light green to red-brown colour.

   b. Normal urine would test negative and remain a light blue colour. The natural yellow of urine might mix with the blue Benedict's reagent and appear slightly greenish. Urine from a person with untreated diabetes would contain glucose, which would test positive in a Benedict's test. The result may be green, yellow, orange, or red depending on the sugar concentration.

10. Test tube samples of plain water (A) and urine Sample X appear normal having no glucose present.

11. Samples with water and sugar (B), and urine Sample Y tested positive for glucose and may indicate diabetes.

12.
    - **Application question 1**: If insulin were taken orally it would be destroyed by protein-digesting enzymes in the stomach and small intestine.
    - **Application question 2**: Low energy results from insufficient glucose entering cells. Large volumes of urine may be excreted as sugar in the nephron creates an osmotic concentration that prevents water from being reabsorbed by the kidney. Acetone may be present on the breath as an intermediate product from cells that are metabolizing fats and proteins in the absence of sugar. As acetone and other ketones build up in the blood, they may be excreted through the lungs. They have a distinct odour somewhat like musty apples or mild paint thinner. The buildup of these waste products also causes the pH of the blood to become acidic.
    - **Application question 3**: Too much insulin would cause an excess of sugar to enter cells and reduce the blood sugar concentration. As the sugar is metabolized by the cells, no more remains in the blood and hypoglycemia results.
    - **Application question 4**: A person who has taken too much insulin may experience a drop in blood sugar levels. The person can be helped by being given more sugar. The sugar can be taken orally provided the person is conscious. If the person is unconscious, they must have immediate medical attention. People with diabetes must monitor their glucose intake, activity levels, and insulin levels continuously to avoid an imbalance.

13. Individuals with diabetes mellitus have inadequate supplies of insulin and have glucose present in their urine. This indicates that blood glucose is in high concentration in the blood and the excess is removed by the excretory system. Since glucose is not usually found in the urine of normal individuals, it can be inferred that insulin plays a role in reducing the amount of blood glucose when its concentration reaches a set point.

14. Glucose is absent in the urine of normal individuals since they have adequate supplies of insulin, which prevent high concentrations of blood glucose. Therefore, blood glucose does not occur in excess and none is released through the urine.

15. Insulin decreases blood glucose levels by making many cells in the body permeable to glucose and causes cells in the liver to convert glucose to glycogen, the primary storage form for glucose.

16. The hormone glucagon is responsible for converting glycogen to glucose in the liver thereby increasing blood glucose levels as the glucose is released.

17. a. insulin b. glucagon

18. Diabetes mellitus is a genetic disorder associated with inadequate production of insulin.

19. Any three of the following symptoms are acceptable: presence of glucose in the urine; production of large volumes of urine; excessive thirst; low energy levels; itchy, blurred vision; and loss of weight.

20. Individuals with diabetes have low energy levels even though they have high blood glucose levels because the glucose is not getting to where it is needed – specifically the cells of the body. Therefore, the cells cannot produce enough energy to maintain the normal metabolic rate. This results in fatigue.

21. Juvenile diabetes is caused by the early degeneration of the insulin-producing beta cells in the islets of Langerhans. Therefore these individuals cannot produce insulin since they no longer have the cells to do so. Maturity-onset diabetes results when the beta cells become less effective and produce less insulin. However, the beta cells do not disappear, they are simply not working to capacity.

    Insulin injections are not always used to treat both types of diabetes. Maturity-onset diabetes generally occurs in individuals over forty years of age and can usually be controlled by diet, exercise, and in some cases special pills containing sulphonamides (restore working capacity of the insulin-producing beta cells).

Section 1: Activity 5

1. A diuretic is a substance which increases urine output. Examples of diuretic substances include alcohol and substances containing caffeine.

2. An antidiuretic is a substance which does the opposite of a diuretic. It decreases urine output.

3. Subject D would have a higher-than-normal level of antidiuretic hormone. This is because this subject has a lower-than-normal urine output.

4. Subjects B, C, and E may have low levels of antidiuretic hormone because they all have higher-than-normal amounts of urine output. It is now necessary to look at urine composition as well as volume.

5. The key substance found in urine which accounts for the increase in urine output is water.

6. a. The subject who suffers from low levels of antidiuretic hormone is Subject E. This individual has a normal urine composition (no glucose or protein) but has a greater urine output.

   b. The reason why Subject B has an increased urine output is because of the presence of glucose in the urine. The glucose increases the osmotic pressure in the urine causing more water to move by osmosis into the urine. This is the same for Subject C except that it is the protein which is causing the increase in osmotic pressure.

7. Antidiuretic hormone reduces the urine output without affecting the composition of the urine other than the amount of water it contains. With ADH secretion, the urine concentration is increased because of a reduced amount of water in the urine.

8.
- **Review question 7**: ADH is antidiuretic hormone also known as vasopressin. It is a hormone which regulates water balance. It is produced in the hypothalamus and stored in the pituitary.
- **Review question 8**: As solute concentration in the blood increases, water is drawn out of the body cells and the cells of the hypothalamus shrink. This stimulates osmoregulators which send a nerve message to the pituitary to release ADH.
- **Review question 9**: The hypothalamus is the thirst center.
- **Review question 10**: Osmoregulators are stimulated, and the pituitary releases ADH. ADH is carried in blood to the kidney. ADH enters the kidney and acts on the collecting duct and upper regions of the distal tubule, making them permeable to water. Greater volumes of water are reabsorbed. This helps prevent additional water loss.
- **Review question 11**: The shrinking of the cells of the hypothalamus initiates a thirst response and you begin drinking.

9. Below-normal secretions of aldosterone decrease the sodium ion concentration in the blood and decrease blood pressure.

10. Above-normal secretions of aldosterone cause an increase in sodium reabsorption into the plasma. This causes an increase in solute concentration, which in turn causes water to move into the plasma through osmosis. The end result is an increase in blood pressure.

11. Aldosterone is responsible for increasing sodium reabsorption into the plasma. This increase in solute concentration results in water moving into the blood plasma. The overall effect is to increase blood volume and blood pressure.

12. With an increase in aldosterone there is an increase in sodium ion reabsorption into the blood plasma in the kidney. The increase in sodium ion (solute) concentration results in an increase in osmotic pressure in the blood. The increased osmotic pressure causes water to move into the blood via osmosis. This increased volume of blood results in an increase in blood pressure.

13. The function of renin is to convert angiotensinogen to its active form – angiotensin. Angiotensin is responsible for constriction of blood vessels and the release of aldosterone from the adrenal gland.

14. Aldosterone carries out its function in the cells of the distal tubule and collecting duct of the nephron.

Section 1: Activity 6

1. Biotechnology involves the use of living things to manufacture products for practical purposes.

2. Examples of organisms used in biotechnology include yeast cells, bacteria, and other microbes.

3. Bovine Growth Hormone could increase milk production and beef production. This would provide more food for a growing population.

4. People may develop allergic reactions.

5. By extracting insulin from bacteria that have been injected with human DNA, insulin is obtained that is more natural for humans and less costly than raising cattle or pigs.

6. These therapies are not considered cures because they only treat the effects of the disorder. They do not prevent the disorder from occurring.

Section 1: Follow-up Activities

Extra Help

1. a. hormones b. messengers c. nervous d. homeostasis e. bloodstream

2. pituitary – a, b, c, h, i thyroid – j parathyroids – g pancreas – f and m adrenal – d, e, k, l

3. a. (v) c. (i) e. (viii) g. (vi) i. (ix) k. (iv)
b. (iii) d. (vii) f. (x) h. (xi) j. (ii) l. (xii)

4. In brackets beside the false responses is the word that should be used to make the statement true.

a. False (**Hyposecretion** of …) b. True c. True d. False (**decreased** production …)

Enrichment

1.

Steroid Hormones	Protein Hormones
Similarities	
• act as chemical messengers	• act as chemical messengers
• reacts with specific cells	• reacts with specific cells
Differences	
• composed of lipid material	• composed of protein material
• fat soluble	• water soluble
• combine with receptor molecules inside the cell cytoplasm	• combine with receptor molecules on the cell membrane
• does not use cyclic AMP	• does use cyclic AMP

2.
- **Critical-Thinking question 1**: Cortisol causes conversion of amino acids to glucose, thereby restoring glucose level. Accelerating the deamination process causes potential problems for both liver and kidney. Excessive amounts of nitrogenous wastes must be converted into the less toxic form, urea. Excessive amounts of urea alter the osmotic pressure of the blood and require elimination by the kidney. Excessively high concentrations of urea can also affect reabsorption from the nephron.

- **Critical-Thinking question 3**: The practice of using hormones in cattle is acceptable as long as tests have been done to indicate that there are no negative effects for the human species. If the hormone benefits the cattle but is harmful to the human population, it should not be used. A potential problem associated with such procedures is control and abuse.

- **Critical-Thinking question 4**: The greater the number of binding sites, the more likely the cell would be to respond to the hormone. Individuals who have many binding sites would react to the hormones more quickly. Fewer binding sites would mean that additional time would be required for the hormone to find the appropriate attachment site. The theory could be tested by adding controlled amounts of releasing factors to hormone-producing cells from two different tissue cultures. The amount of hormone produced by each tissue culture could be monitored. (**Note**: Both tissue cultures must be the same size.) There are other possible solutions other than this one.

3. - **Critical-Thinking question 1**: Increased fluid intake will increase filtration. By suppressing the release of ADH, higher volumes of less-concentrated urine will be produced. This indicates a potential benefit. However, there are some important implications to note concerning excessive alcohol consumption by moving more fluid through the kidneys. Decreased liver function associated with cirrhosis will decrease important plasma proteins such as angiotensinogen and albumin, which are important in regulating water balance and blood pressure.

   - **Critical-Thinking question 2**: If coffee is consumed, then urine production will increase. This is assuming the experimental group and the control group have gone through the same routine with respect to eating, drinking, and physical activity.

   - **Critical-Thinking question 3**: A variety of different experiments could be developed. Variables must be controlled and the collection period should be for at least one hour following the consumption of fluids. The following provides a sample: Have 100 resting subjects drink only water for a twenty-four-hour period. Record urine output during that period and record the amount of water consumed. A few days later, have the same subjects drink the same amount of coffee at the same time of day and record urine output. The subjects should attempt to maintain the same amount of activity for both testing days.

4. The purpose of this exercise is to make you aware of new research and findings being done in this area of study. For example, a substance known as Parsol 1789 has been one of the newer ingredients placed in sunscreen lotions. This substance is believed to provide you with the greatest range of UV-A protection. However, studies have indicated that Parsol 1789 may damage skin cells. This presents a problem for people wanting to stay out in the sun but not get burned. What are they going to use?

5.

Hypoglycemia	Diabetic Ketoacidosis
Causes	
• too much circulating insulin • delayed or missed meals • prolonged exercise without extra food • alcohol ingestion	• insufficient insulin • infection • poorly controlled diabetes • unusually prolonged stress (physical or emotional) • undiagnosed diabetes
Symptoms	
• cold, clammy, sweaty skin • trembling, shakiness of hands • tingling or numbness of lips and mouth • confusion, disorientation • slurred speech • headache • hunger • seizures	• extreme thirst • frequent urination • dry flushed skin • nausea • vomiting • abdominal pain • eventual unconsciousness
Treatment (must be treated immediately)	
• provide sugar • dextrose tablets (3) • glucose tablets (2) • Life Savers® (5-6) • juice or regular pop (not diet pop) (180 mL)	• go to hospital

Section 2: Activity 1

1. From birth, testosterone secretion slowly increases until about age 9. From the ages of 9 to 20, levels rise dramatically and peak. From the age of about 20 on, testosterone secretions decrease steadily.

2. This period of time involves the stage of puberty and adolescence. Some physical changes that occur in the male body include the development of body and facial hair, the growth of the larynx which causes the lowering of the voice, and the strengthening and growth of muscles.

3. Testosterone production is controlled by the male luteinizing hormone (LH) from the pituitary.

4. Testosterone is produced in the interstitial cells of the testes.

5. Sperm cell production is called spermatogenesis.

6. Other characteristics include the development and growth of bone, increased oil secretion from the skin (contributes to acne), and more perspiration secretion from the sweat glands.

7. The two structures which control secretion of testosterone are the hypothalamus and the pituitary.

8. Gonadotropin hormones are produced in the anterior pituitary and their function is to regulate the functions of the testes.

9. The two gonadotropin hormones include follicle-stimulating hormone (FSH) and luteinizing hormone (LH). FSH is responsible for stimulating the production of sperm cells in the testes. LH promotes the production of testosterone by the interstitial cells.

10. • **Review question 8**: At puberty, the hypothalamus secretes gonadotropin-releasing hormone (GnRH). GnRH activates the pituitary gland to secrete and release LH. LH acts on the interstitial cells to produce testosterone. In turn, the testosterone itself increases sperm production. Once high levels of testosterone are detected by the hypothalamus, a negative-feedback system is activated. Decreased GnRH production slows the production and release of LH and leads to less testosterone production. Testosterone remains in check.

11. • **Review question 18**: Prostaglandins are hormones that have a pronounced effect in a small localized area of the body.

12. Secondary sex characteristics in females include development of breasts and body hair, increased fat deposits in the hips and breasts, and widening of the hips.

13. The hormone released from the hypothalamus in both males and females is gonadotropin-releasing hormone (GnRH).

14. The hormones released from the anterior pituitary are FSH and LH.

15. The homeostatic mechanism which decreases secretion of estrogen and progesterone is negative feedback caused by inhibition of FSH and LH by the hypothalamus – pituitary complex.

Section 2: Activity 2

1. a. uterus (womb) – the female organ in which the fertilized ovum (egg) normally becomes embedded and in which the embryo and fetus develop

   b. endometrium – the glandular lining of the uterus that provides nourishment for the embryo

c. menstruation – the shedding of the endometrium

d. follicle – structures in the ovary that contain the egg and secrete estrogen

e. ovulation – the process where the egg is released from the follicle in the ovary

f. corpus luteum – the remains of the follicle after ovulation which functions by secreting estrogen and progesterone

2. The average length of each menstrual cycle is 28 days. However, it is normal to have menstrual cycles which are 21 days to 35 days long.

3. The four phases of the menstrual cycle are the flow phase, follicular phase, ovulation phase, and luteal phase. In the flow phase (days 1-5), menstruation takes place. In the follicular phase (days 6-13), the follicles develop in the ovaries and the endometrium is restored. The ovulation phase (Day 14) is where the egg is released from the ovary. The luteal phase (days 15-28) involves the thickening of the endometrium and the formation of the corpus luteum.

4. In the ovarian cycle, the follicle develops and matures resulting in the release of a mature ovum (egg). With the release of the egg, the remains of the follicle develop into the corpus luteum which serves as an endocrine gland. In the menstrual cycle, the endometrium is first shed and the rest of the cycle involves the redevelopment and thickening of the lining.

5. Estrogen is produced in the growing follicle and corpus luteum. Progesterone is produced in the corpus luteum.

6. The role of estrogen with respect to the endometrial lining is to develop and maintain it.

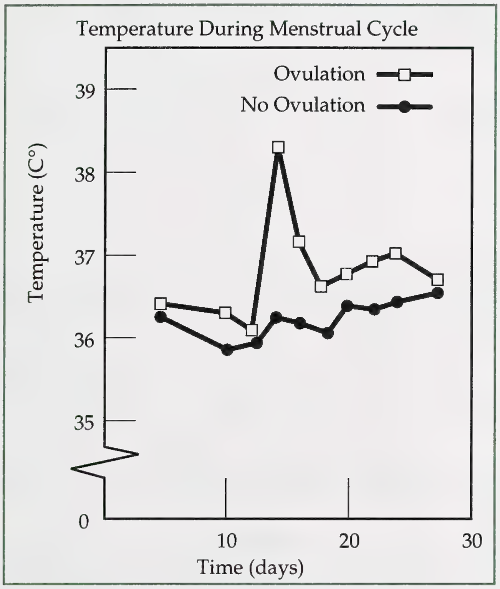
7. Progesterone continues to stimulate the endometrium and prepare the uterus for an embryo. It also inhibits further ovulation.

8. The release of GnRH is due to the onset of female puberty.

9.

Ovarian Cycle (deals with the ovary)	Menstrual (Uterine) Cycle (deals with the uterus)
The release of FSH stimulates **follicle development**.	
Follicle secretes estrogen which causes **increased secretion of LH**.	The function of estrogen is to **initiate development of the endometrium**.
LH secretion causes the process of **ovulation**.	
Continued influence of LH causes the formation of **the corpus luteum**.	
Corpus luteum causes the secretion of **estrogen and progesterone**.	Buildup of estrogen and progesterone causes **increased development of the endometrium**.
High estrogen and progesterone levels inhibit the release of **FSH and LH**.	
The inhibition of the gonadotropin hormones causes deterioration of **corpus luteum**.	
	Decreased estrogen and progesterone levels cause **menstruation**.

10.
- **Procedure question a**: FSH is represented by *x* and LH is represented by *z*. Both hormones are secreted by the pituitary. FSH promotes development of the follicle; whereas LH promotes development of the corpus luteum.
- **Procedure question b**: Estrogen is represented by *w* and progesterone and some estrogen are represented by *y*. Estrogen exerts negative feedback to the pituitary from the follicle, whereas progesterone and some estrogen exerts negative feedback to the pituitary from the corpus luteum.
- **Procedure question c**: Estrogen and progesterone exert negative feedback effect.
- **Procedure question d**:



- **Procedure question e**: Assuming the menstrual cycle represents the average 28-day cycle, ovulation occurs on Day 14.
- **Procedure question f**: The temperature decreases prior to ovulation and rises above normal body temperature during ovulation.
- **Procedure question g**: Body temperatures with a functioning corpus luteum are higher than those without.
- **Procedure question h**: Ovulation occurs at X and menstruation occurs at Z. Notice that Z is actually where the graph started on the vertical axis.
- **Procedure question i**: Estrogen is being produced at W and X.
- **Procedure question j**: Estrogen and progesterone are produced by the corpus luteum at Y.
- **Procedure question k**: LH increases progesterone and estrogen levels by stimulating the formation of the corpus luteum. The corpus luteum produces both female sex hormones.

11. Ovulation occurs on Day 14.

12. On Day 28 the endometrium is well developed.

13. In the case where fertilization does not occur, the endometrium deteriorates. In the case of fertilization, the endometrium continues to develop.

14. In the case of no fertilization, the corpus luteum degenerates. If fertilization occurs, the corpus luteum survives and grows larger.

15. Without fertilization, the level of progesterone drops. If fertilization and implantation occurs, the level of progesterone remains high.

16. The deterioration and shedding of the endometrium does not occur if fertilization and implantation have occurred.

Section 2: Activity 3

1. If the follicles are not developing, there is no secretion of estrogen. If there is no secretion of estrogen, there will be no development of the endometrium, there is no negative feedback message to turn off FSH secretions, and there is no positive message to increase LH levels.

2. If there is no menstrual cycle, progesterone is not produced. Consequences of not having this hormone are that there is no further development of the endometrium.

3. Once the menstrual cycle stops, reproduction is not possible because no ovulation takes place. If there is no egg being released, sperm cells do not have anything to fertilize.

4. If GnRH is not released, FSH and LH will not be secreted by the anterior pituitary. If FSH is not released, there is no maturing of the follicle, and if LH is not released, there is no ovulation.

5. Because of the action of the pill, there is no development of a follicle and there is no ovulation. Without these events taking place, a pregnancy is impossible.

6. Since the pill is composed of estrogens and progesterone, these hormones will develop and maintain the endometrium.

7. Once a woman stops taking the pill after the twenty-first day, her estrogen and progesterone levels drop off. This causes menstruation of the endometrium.

8. The ovarian cycle is most affected by oral contraceptives. Ovulation is prevented.

9. Some long-term effects of taking oral contraceptives include blood clotting, atherosclerosis (hardening of the arteries), and heart attacks. Smoking in addition to taking birth control pills increases the chances for death.

10. It is important to think through this question. An emotional response is not acceptable. A possible answer could be the following: No, I do not think women should take birth control pills if the long-term effects are valid. Taking oral contraceptives is not the only way to prevent pregnancy. The use of a latex condom prevents pregnancy if used properly and also protects against sexually transmitted diseases. The safest scenario is abstinence until a woman feels she wishes to have a child.

11.

Effects in Teenagers	Effects in Women	Effects in Men	Effects in All Individuals
• prevents expansion of bone parts	• decreases breast size • deepens voice • increases facial and body hair	• increases breast development • shrinks testes • causes possible impotence	• increases risk of atherosclerosis and heart disease • liver dysfunction • increases risk of cancer (liver) • kidney dysfunction • decreases effectiveness of immune system

Section 2: Follow-up Activities

Extra Help

1. a. estrogen
   b. progesterone
   c. testosterone
   d. testosterone
   e. progesterone
   f. estrogen
   g. testes
   h. interstitial
   i. cells
   j. ovaries
   k. puberty
   l. twenty
   m. primary
   n. secondary
   o. estrogen
   p. sex
   q. pregnancy
   r. hypothalamus
   s. pituitary
   t. testes
   u. ovary

2. a. FSH causes the development of the follicle, which contains an egg.

   b. An increase in estrogen levels causes the development of the endometrium.

   c. Estrogen peaks before the gonadotropin hormones.

   d. Ovulation occurs just after the peaking of the gonadotropin hormones. **Note**: Because of the greater concentration of LH over FSH, LH plays a more important part in causing ovulation.

   e. As the corpus luteum is forming, progesterone levels are increasing. When the corpus luteum is disintegrating, progesterone levels decrease.

   f. When estrogen and progesterone levels are high, the endometrium continues to develop and be maintained.

   g. When the levels of ovarian hormones drops, the endometrium lining is shed (decreases in thickness).

3. a. A b. M c. A d. M e. A f. M g. B h. M

Enrichment

1. - **Critical-Thinking question 2**: Levels of FSH and LH could be increased or decreased. Ovulation, the thickness of the uterine lining, and hormone (estrogen and progesterone) levels could be monitored. The experimental design should attempt to control variables. A great variety of experiments can be attempted. The three methods of hormonal research – extirpation (removal of the gland), graft, and chemical isolation and injection – may be employed. See Chapter 14 for further information on hormone research.

2. By charting your periods, you will have a better idea of your personal cycle. If there are sharp deviations from your normal period such as heavier or lighter flow, any unusual pain or clotting, or a shorter or longer time between periods, you will know something is unusual. This is the time to get it checked out by your doctor.

3. Newspaper articles are an excellent resource to research areas such as anabolic steroids. A collection of these articles would give you a better perspective of what anabolic steroids are all about. There are newspaper articles which range from dealing with how steroids are sometimes masked to prevent detection to anabolic steroids being used as a contraceptive for males. The more you are able to find out about anabolic steroids, the better your understanding will be concerning the effects of these drugs.

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